Ecosystem Considerations 1997

Compiled and Reviewed by
The Plan Teams for the Groundfish Fisheries
of the Bering Sea, Aleutian Islands, and Gulf of Alaska

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INTRODUCTION

Since 1995, the NPFMC Groundfish Plan Teams have prepared a separate Ecosystem Considerations (EC) section to the annual SAFE report. The 1995 EC report presents a compendium of general information on the Bering Sea, Aleutian Island, and Gulf of Alaska ecosystems as well as a general discussion of ecosystem management. The 1996 EC report provided additional information on biological features of the North Pacific, and highlighted the effects of bycatch and discards on the ecosystem. This edition provides a review of ecosystem-based management literature, presents updates of ongoing ecosystem research, and provides new information on seabirds, marine mammals, and "essential fish habitat".

ECOSYSTEM CONSIDERATIONS

by Dave Witherell

What is an Ecosystem?

Likens (1992) defined an ecosystem as a spacially explicit unit of the Earth that includes all the organisms, along with all components of the abiotic environment within its boundaries. In addition, ecosystems are dynamic in space and time, and no ecosystem is closed with respect to exchanges of organisms, matter, and energy (ESA 1995).

In 1995, the groundfish plan teams proposed that Alaska has three large marine ecosystems: the Bering Sea, the Aleutian Island chain, and the Gulf of Alaska.

What is Ecosystem-Based Management?

A multitude of state and federal agencies involved in natural resource management have adopted ecosystem-based management strategies as a response to biodiversity concerns. It seems that each agency has developed its own definition and goals of ecosystem-based management [also just termed ecosystem management]. A review of several definitions of the concept is provided here.

Grumbine (1994) reviewed 34 published papers on ecosystem management to determine where consensus exists among the various definitions and concepts. From his review, Grumbine developed ten dominant themes of ecosystem management. The themes were: hierarchical context (systems perspective), ecological boundaries, ecological integrity, data collection, monitoring, adaptive management, interagency cooperation, organizational change, humans imbedded in nature, and human values. From these themes, Grumbine developed a working definition: "*Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term.*" Grumbine further states that "ecosystem management is not just about science nor is it simply an extension of traditional resource management; it offers a fundamental reframing of how humans may work with nature."

The five goals of ecosystem management (Grumbine 1994).

1. Maintain viable populations of all native species in situ.
2. Represent within protected areas, all native ecosystem types across their natural range of variation.
3. Maintain evolutionary and ecological processes (i.e, disturbance regimes, hydrological processes, nutrient cycles, etc.).
4. Manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems.
5. Accommodate human use and occupancy within these constraints.

The Oregon Department of Fish and Wildlife (1994) defines ecosystem-based management as a strategy that "*integrates scientific knowledge of ecological relationships with sociopolitical values to maintain long term relationships with sociopolitical values to maintain long-term system viability through collaborative stewardship of ecosystem components; including their functions, processes, interactions and intrinsic value.*" More specifically, the ODFW ecosystem-based strategy is to conserve, restore, and enhance ecosystems (including their functions, processes, constituent species, and productive capacities) by integrating ecological, social, and economic factors.

The Ecological Society of America (1995) defines ecosystem management as "*management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem structure and function.*" The eight listed elements are considered mandatory, with sustainability being the primary goal of ecosystem management. Further, they note that with human population growth and increasing demands for ecosystem goods and services, there is a compelling need for sustainablilty.

The elements of ecosystem management (Ecological Society of America 1995).

1. Long-term sustainability as fundamental value.
2. Clear, operational goals.
3. Sound ecological models and understanding.
4. Understanding of complexity and interconnectedness.
5. Recognition of the dynamic character of ecosystems.
6. Attention to context and scale.
7. Acknowledgment of humans as ecosystem components.
8. Commitment to adaptability and accountability.

The goals of the Alaska Maritime Wildlife Refuge ecosystem plan (USFWS 1994).

1. Maintain species diversity and natural populations consistent with the natural ecological process.
2. Maintain and restore natural habitats across their full range of variations.
3. Manage the human use of species and habitats consistent with all ecosystem management goals.
4. Promote integrated management of ecosystems through partnerships and informed public.

The Bering Sea/Aleutian Island Ecosystem Management Plan developed by the U.S. Fish and Wildlife Service identified four goals as part of its Alaska Maritime National Wildlife Refuge ecosystem plan. These goals are listed in the adjacent box.

Mangle et al. (1995) describe principles for the conservation of wild living resources and mechanisms to implement them. The principles are:

I. Maintenance of healthy populations of wild living resources in perpetuity is inconsistent with unlimited growth of human consumption of and demand for those resources.

II. The goal of conservation should be to secure present and future options by maintaining biological diversity at genetic, species, population, and ecosystem levels: as a general rule neither the resource nor other components of the ecosystem should be perturbed beyond natural boundaries of variation.

III. Assessment of the possible ecological and sociological effects of resource use would precede both proposed use and proposed restriction or expansion of ongoing use of a resource.

IV. Regulation of the use of living resources must be based on understanding the structure and dynamics of the ecosystem of which the resource is part and must take into account the ecological and sociological influences that directly and indirectly affect resource use.

V. The full range of knowledge and skills from the natural and social sciences must be brought to bear on conservation problems.

VI. Effective conservation requires understanding and taking account of the motives, interests, and values of all users and stakeholders, but not simply averaging their positions.

VII. Effective conservation requires communication that is interactive, reciprocal, and continuous.

What's New in Ecosystem-Based Management?

In 1996, the National Research Council's Committee on the Bering Sea Ecosystem released a report entitled "The Bering Sea Ecosystem." The Committee was tasked by the State Department to study the population dynamics and changes in marine mammals, seabirds, and commercially important species in the ecosystem and the probable causes of the changes. They also set out to identify gaps in knowledge and identify alternative management strategies. The committee concluded that changes in the Bering Sea ecosystem over the past 50 years are due to a combination of environmental change and human impacts. Their "cascade hypothesis" is based on changes in the physical environment acting in concert with human exploitation of long lived predators (such as whales) to create an environment in which pollock thrive. Hence, some changes that have occurred are likely irreversible in human time frames. They recommend that the Council utilize active adaptive management as a research tool, and that management adopt an ecosystem perspective. To reverse declines in marine mammals and birds, the Committee suggests that *fishing effort for pollock be broadly distributed over space and time.* A copy of the full report is available from the National Academy Press.

What Steps to Ecosystem-Based Management Have Been Undertaken in the North Pacific?

The North Pacific Fishery Management Council and the National Marine Fisheries Service have enacted certain measures that are consistent with an ecosystem-based management strategy. Although some measures may have ecosystem management consequences, most were taken specifically to mitigate impacts of fisheries on reduced populations. A number of these measures are described below.

- **Two million metric ton OY cap.**
  In 1984, the Council established a total allowable catch of all BSAI groundfish at 2 million metric tons. This limit, or cap, was based on biological data that indicated MSY for this complex at 1.8 to 2.4 million metric tons. The optimum yield (OY) was set at 85% of the MSY range, or 1.4 to 2 million metric tons. Improved biological information has indicated that this limit is indeed conservative, as the sum of ABCs for the BSAI area in recent years has ranged from 2.5 to 3.2 million mt. The Council has maintained the 2 million mt OY cap for conservation reasons, despite several efforts from fishing industry groups to raise the cap. The result has been very conservative exploitation rates for some groundfish (e.g., flatfish species), whereas other species have been fully exploited (e.g., pollock).
- **Spatial and Temporal Allocation of Groundfish Harvests.**
  Fisheries have been both seasonally and spatially allocated to reduce potential impacts of localized depletion. For example, the Bering Sea pollock TAC is split among a winter fishery (A-season) and a late summer fishery (B-season). In the GOA, pollock is spatially apportioned into regional areas. Regional apportionment is also done for Atka mackerel in the Aleutian Islands. Because Atka mackerel and pollock are important prey for higher trophic levels, these measures reduce the impacts of harvesting on the ecosystem.

- **Incorporation of Risk Aversion into GOA Pollock ABC.**
  In 1993, the GOA pollock assessment examined the effect of various fishing mortality rates that balanced the risk of reducing spawner biomass below a threshold level (Hallowed et al. 1993). The models employed estimated measurement error and process error (recruitment variability). This approach introduced the concept of foregoing catch to lower the risk of spawning stock declines. Despite the lack of compelling evidence linking fishery removals with the decline of Steller sea lions, the Council adopted a cautious approach for pollock management. This risk averse approach

for pollock reduces the possibility that the GOA pollock fishery will exacerbate declines of Steller sea lions.

- **Incorporation of Uncertainty in Establishing Groundfish Harvest Rates**.
  In 1996, the Council adopted a more conservative overfishing definition under Amendment 44/44 to the BSAI and GOA fishery management plans. Overfishing is a level or rate of fishing mortality that jeopardizes the long-term capacity of a stock to produce maximum sustainable yield on a continuing basis. The new definition instituted new safeguards against overly aggressive harvest rates, particularly under conditions of high uncertainty or low stock size. The new definition sets a maximum allowable fishing rate as prescribed through a set of six tiers corresponding to information availability. In addition, a buffer will be maintained between acceptable biological catch (ABC) and the overfishing level. Under current stock conditions, ABC's were reduced for flatfish, sablefish, and many rockfish species in both the GOA and BSAI areas.

- **Establishment of Marine Mammal Buffer Zones.**
  Amendment 20/25 to the BSAI and GOA fishery management plans established a framework that allows for implementation of marine mammal conservation measures. Regulations promulgated under this framework include buffer zones around Steller sea lion rookeries and walrus haul-outs. These regulations reduce direct and indirect interactions of marine mammals with fishing operations.

- **Area Closures to Protect Habitat**
  Both Amendment 21a and Amendment 37 established trawl closure areas specifically to protect habitat from potential impacts due to trawling. Amendment 21a implemented the Pribilof Habitat Conservation Area, which contains essential habitat (shell hash) for juvenile blue king crabs, and is a foraging area for major concentrations of seabirds nesting on the islands. Amendment 37 implemented the nearshore Bristol Bay closure area, which contains essential habitat (invertebrate epfauna) for juvenile red king crab. Although the impacts of trawling on crab stocks has not been quantified, the Council took a precautionary approach by protecting critical habitat.

- **POP Rebuilding Plan**
  In 1993, the Council adopted a rebuilding plan for GOA Pacific ocean perch under Amendment 32. This stock had been depleted by foreign fisheries in the mid-1960s. The plan established a target spawning biomass and a rebuilding schedule based on a very conservative harvest strategy. A follow-up amendment (Amendment 38) allows the removal rates to be set even more conservatively to hasten rebuilding of this stock. Because Pacific ocean perch are a long-lived component of the GOA fish community, the rebuilding plan falls within the realm of an ecosystem-based management strategy.
- **Bycatch Limits**
  Regulations have been implemented to reduce bycatch of red king crab, Tanner crab, halibut, herring, and salmon taken in groundfish fisheries.

- **Forage Fish Protection**
  Analysis of an amendment package that examines the impact of a prohibition on fishing for forage fish (smelts, in particular) is currently in preparation. The FMP defines smelts to include capelin (*Mallotus villosus*), rainbow smelt (*Osmerus mordax*), and eulachon (*Thaleichthys pacificus*), which are important prey for groundfish, seabirds, and marine mammals. Currently, smelts are included in the "other species" category and assigned a TAC for the category as a whole. The Council is considering taking a proactive move by preventing fisheries for these important species from expanding or developing.

What's in the Works for Ecosystem-Based Management for the North Pacific?

NPFMC Ecosystem Committee -- In 1996, the NPFMC established an Ecosystem Committee to discuss possible approaches to incorporating ecosystem concerns into the fishery management process. The Committee met on September 18 to discuss the role and objectives of the committee. The following summary outlines the functions of the committee as well as some specific comments and recommendations suggested by those present at the first committee meeting.

1. Provide a platform to educate policy makers, researchers, fishermen, and others on ecosystem related topics.

   Suggestions and comments included: identify fisheries management programs around the world where elements of ecosystem based management have already been incorporated; review ongoing studies of the Bering Sea and Gulf ecosystem (e.g., FOCI); improve communication among scientists of different disciplines; interact with Plan Teams, PICES, and other groups; develop a working library of relevant literature.

2. Obtain additional information.

   Suggestions and comments included: obtain knowledge from resource users in coastal communities; obtain environmental and other data from fisheries vessels through observer program; determine if disturbances imposed by humans are qualitatively and quantitatively different from natural impacts; determine how fishing impacts the ecosystem; develop simulation models for prediction of impacts.

3. Develop a working definition for ecosystem management in the context of the NPFMC.

   Suggestions and comments included: identify programmatic objectives; develop management approaches which add sustainability of marine communities not just commercially important species; avoid irreversible impacts to target and non-target species as well as habitats; recognize people are part of the ecosystem; given that information will always be limited, apply precautionary principles to minimize impacts of fisheries; consider the relevance of spatial and temporal scales by shifting management prescriptions from the traditional 1 year cycle since major ecosystem changes occur over longer time periods; understand that ecosystem based management means managing the impacts of human harvest practices on the ecosystem rather than "managing" the ecosystem.

4. Develop policies for ecosystem-based management.

   Suggestions and comments included: suggest ways the Council can implement ecosystem concepts; set the stage for future fisheries management per Magnuson Act and national ecosystem program.

5. Provide advice.

   Suggestions and comments included: provide advice to the Council on ecosystem based management approaches including adaptive management; provide direction and feedback for ecosystem level research; serve in advisory role for definition of essential fish habitat as mandated by recent Magnuson Act amendments.

The Committee solicited comments from fishermen and residents of coastal communities on their observations through the Council newsletter. Specifically, comments were requested regarding: observed changes in the local ecosystem; observed changes in the local marine environment; abnormal or unusual phenomena; patterns or seasonal changes felt to be important to the local ecosystem; and traditional knowledge which explains patterns or relationships in the local ecosystem. It was felt that a summary of these observations could be part of the Council's annual Ecosystem Chapter. Other suggestions for obtaining local knowledge included working with Rural Alaska Community Action Program (Rural CAP), Bering Sea Fishermen, Alaska Science Commission, and the Alaska Marine Conservation Council.

Magnuson Act Amendments Regarding Essential Fish Habitat (by Tamra Faris) — Amendments to the Magnuson Act add major new responsibilities concerning essential fisheries habitat (EFH). The major portions of the EFH mandates contained in the Magnuson/Stevens Act reauthorization (Sections 101, 102, 108, 305) direct:

- NMFS to develop guidelines, by regulation, to assist Councils in the description and identification of EFH, including threats and conservation measures, within 6 months of the date of enactment of the bill.

- NMFS, in consultation with the fishing industry, to provide each Council with recommendations and information regarding each fishery under that Council's authority to assist in the identification of EFH, adverse impacts to EFH, and actions to ensure conservation and enhancement of that habitat.

- Councils to describe and identify EFH for each FMP, along with threats to and conservation measures for such habitat, for the fish species in the subject fishery.

- Councils to amend all FMPs implementing the new requirements, including EFH, within 24 months of the date of enactment.

- As an ongoing activity the Secretary of Commerce is to recommend conservation measures for any action undertaken by any State or Federal Agency that would adversely affect any EFH.

These new requirements will require considerable work by NMFS and the Council to implement. To begin the task, NMFS appointed a Working Group from among the various regional and center programs. Members of the group first prepared white papers [these are available but probably not of lasting significance] describing differing interpretations of the definition for EFH and the implications of applying those definitions to describing and identifying EFH, then met September 16 through 19, 1996, in Georgetown, D.C. Conclusions of the workshop are summarized below followed by the tentative outline of guidance and preliminary implementation schedule.

Definition - S. 39 defines EFH to mean "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". Key points of the Working Group's interpretation of that definition include: (1) waters which are habitat should include waters with those physical, chemical, and biological properties that make water habitat for a species of fish; (2) substrates include sediments, structures underlying the waters, and associated biological communities; (3) necessary should mean habitat necessary to support a managed species at MSY; (4) EFH should cover the full life cycle and access to that habitat; and (5) EFH may be identified by individual species or as assemblages, whatever is appropriate for a particular FMP.

Description and Identification - With regard to a process to describe and identify EFH, the Working Group recommended that the guidelines call for a four tiered approach based on the amount of life history information and species habitat and distribution data that are available. Tier one would be used if only presence/absence data are available and EFH could be everywhere that species occurs, particularly if the stocks of the species are below MSY. Tier two would be used if abundance data are available and EFH would include areas of medium to high abundances. Tier three would be used if information on the life history rates by habitat is available and EFH would include areas of greatest successful growth, reproduction, and survival. Finally, tier four would be used if production rates by habitat are available and EFH would be that habitat necessary to support the objectives of a fishery management plan (i.e., MSY). The advantages of this proposed process are that it is scientifically based; uses the best information available; is linked to the goals of FMPs; and is conservative if information is lacking. While NMFS' goal should be to strive to apply tier four to all species, data and scientific linkages are not currently available to do this for most species.

The Working Group recommended that general maps of EFH be provided because the physical, chemical, and biological properties of habitat may change location based on both man's actions and natural variability. Historical data will have to be used in determining a probability estimate of where EFH is located at any one time. The Working Group also concluded that if scientific evidence exists of a linkage between a managed species and a prey species, or a group of prey species, then the EFH for the prey species should be considered to be part of the EFH for the managed species.

Outline, as of 9/19/96, for the guidelines to be established by the Secretary under 305(b)(1)(A):

Title: Guidelines on Essential Fish Habitat Requirement

I. Purpose and Introduction

II. Overview of Statutory Requirements
   - A. Definition
   - B. Content of FMP's
   - C. Actions by the Secretary
   - D. Actions by the Councils

III. Specific EFH Requirements in FMP's
   - A. Description of Habitat (Present and Historical)
     1. Description of habitat (present/historical)
        - a. spawning, breeding, feeding, growth to maturity, as well as access those locales (include schematic)
     2. Description of Habitat for Prey Species (as appropriate)
        - a. as above
     3. Description of EFH for target and any prey species (tier 1-4)
     4. Scientific Justification (i.e., these resources must be available for FMP species to remain or recover to FMP-objective levels)
   - B. Identification of Essential Fish Habitat
     1. General mapping
        - a. range of species (tier 1-4)
          1. present
          2. historical
          3. predator/prey, trophic transfer relationships
   - C. Adverse impacts to Essential Fish Habitat
     1. Identify activities including fishing with potential EFH impacts
     2. Describe, on a marine ecosystem or watershed basis, impacts on EFH for each activity with special consideration of impacts on limiting and controlling habitat factors
     3. What habitat functions are thus likely to be affected?
     4. Scientific Justification: (provide documentation of impacts)
   - D. Actions to ensure the Conservation and Management of EFH; For each significant threat identify:
     1. Actions to Minimize Fishing Effects -- Propose actions to minimize adverse effect on EFH caused by fishing.
     2. Responses to non-fishing threats -- Identify direct responses to non-fishing threats (prohib's, restrictions, time-area closures, sanctuaries/reserves, special requirements, mitigation, other conservation management measures)

3. Remediation/Restoration opportunities/options
4. Scientific justification: document effectiveness of responses/actions.

E. Information and Research Needs -- Within tiered approach leading ultimately to level 4, ID information gaps and required research agenda.

Magnuson Act Amendments Regarding Ecosystem Research -- Amendments to the Magnuson Act include a mandate that ecosystem-based management be considered for marine fisheries. Specifically, the Secretary must establish a panel by April 1997 to develop recommendations to expand the application of ecosystems principles in fishery conservation and management activities, and report the panel's findings to Congress by October 1998. The panel must include Council representatives, among others.

What are the Plan Team's Specific Ecosystem Concerns?

As in previous years, there are a number of specific ecosystem concerns that the Council and NMFS should consider in the process of setting the 1997 groundfish TACs. While the Teams are not able to provide quantitative recommendations, these concerns suggest serious consideration of more conservative management choices wherever those options exist.

Fishery Effects on Species Composition -- Large differences exist in the harvest rates of groundfish species off Alaska--some are harvested at or close to their F_{abc} levels while others are harvested substantially below them. Walleye pollock, Pacific cod, sablefish, and most of the rockfish species have been harvested at or close to their estimated ABCs since their history of management under the MFCMA. Flatfishes, on the other hand, have been exploited substantially below ABCs in both the BSAI and GOA.

The abundance of all flatfish species off Alaska (except for Greenland turbot in the Bering Sea) have been very high. In the Bering Sea, for example, the abundance of all flatfishes combined have increased from about 2.8 million t from 1979 to more than 6.7 million t in 1994. Their combined ABCs and TACS for 1994 were 868,400 t and 467,325 t, respectively. This is 46 percent of the full ABC as set by the Council. In reality the catch of these flatfish species totaled less than 270,000 t in 1994; thus, flatfishes were 69 percent of ABC. Because the utilization of the flatfish resources are constrained by bycatch limits for prohibited species (like crabs and Pacific halibut) and lack of commercial value, the catches are much less than ABC. The low catches combined with good recruitment have kept their biomass high; thus creating greater predation pressure on the prey community.

High biomasses of predator species may have great impacts on the trophodynamics of the marine ecosystem and shift the species composition. The flatfishes are major predators of forage fish (including juvenile pollock) and benthic organisms. Crabs that substantially overlap the fish feeding range would be subject to heavy predation. While more is known about crab-fish interactions, other crustacean resources, like shrimp, may also have been negatively impacted by high abundance of flatfishes.

Impacts of Fishing Gear on Habitat and Ecosystems -- The Teams are concerned about the effects of fishing are on seafloor habitats and trophic dynamics, and the Teams support continued research on this question. There are numerous papers on this subject published in the literature. Some research has shown that bottom trawling and other gear types can alter the bottom structure, sediments, and nutrient cycling in certain situations. Other studies have shown little, if any, long term effects. The Teams intend to provide a complete review of this literature in the next ecosystem considerations chapter.

Localized Depletion of Atka Mackerel -- If fish removals are disproportionately high relative to available biomass, localized depletions of the target stock may occur. New research has indicated that trawling can cause localized depletion of Atka mackerel when fishing effort targets on that species (Fritz 1996). The patterns of CPUE observed suggest that the Atka mackerel fishery can have significant impacts on local fish abundances which may remain for weeks after the fishery has left the area. Given the uncertain status of Atka mackerel abundance and recruitment ,and efforts to recover Steller sea lions, temporal and spatial aspects of fish removals be considered more fully in setting ABCs, managing fisheries, and recovering protected species.

Climatic Changes -- This draft has included a section on "ecosystem change" and ongoing research on the subject. Shifts between warm and cool eras appear to occur on a decadal or greater (e.g., 18.6 years) frequency in the North Pacific Ocean. Such shifts in physical conditions may also be associated with changes in ocean productivity. A relationship between oceanic conditions and increased production of a variety of plankton, nektonic fish and cephalopods has been hypothesized. Year class strengths of commercially important species have also been related to oceanic temperature conditions. A review dating back to 1948 of 23 fish stocks indicates that 43% of them had more frequent strong year classes during a particular type of ocean temperature regime (e.g., warm or cold). A somewhat longer time scale relationship has also been hypothesized for salmon. Compelling links between ocean conditions and production can be seen in strong year classes of a number of Bering Sea fish stocks (pollock, Pacific cod, Pacific herring) spawned at the onset of warm current regimes (1976-77) that are accompanied by apparent simultaneous decline in stocks of some other finfish (e.g. capelin), shrimps, and king crabs).

Decreases in marine mammal and increases in the arrowtooth flounder population have been previously discussed. However, evidence is now accumulating of large decreases in the abundance of forage fish and fish eating seabirds in the GOA. Because of the apparent changes in the ecosystem components, the Plan Team encourages the Council to consider a broader look when setting TACs for individual species.

Forage Fish Species -- Based upon concerns expressed on this issue last year, a plan amendment has now been drafted to prohibit target fisheries on forage fish species in both the GOA and BSAI. As opportunities to harvest pollock decrease in the Gulf of Alaska, for example, the potential for displacement of fishing effort into new fisheries may increase. The development of new fisheries on underutilized species is not to be discouraged; however, significant changes in exploitation of forage fish, for example, may exacerbate efforts to manage declining populations of non-target species such as Steller sea lions and harbor seals. This draft amendment is now out for public review.

Seabird Declines -- Declines of some North Pacific seabirds have largely been ascribed to reduced availability of forage fish. Seabirds feed on walleye pollock (exclusively 0-and 1-class fish), herring, and several other forage fish species. Seabirds depend on an adequate abundance and diversity of fish prey in the vicinity of each breeding colony. Prey availability near colonies varies due to current and other abiotic factors, but prey is probably most reliable when overall forage stocks are large. The Plan Team therefore suggests conservative management choices for pollock, wherever these options exist, and a prohibition on new directed fisheries for “forage species”.

Bycatch of seabirds in groundfish fishing gear was approximately 10,000 birds in 1993. Ninety percent of the birds taken were taken on longliners. The greatest concern is for the endangered Short-tailed Albatross. If two or more short-tailed Albatross are caught in one year, the longline groundfish fishery could be shut down under Section 7 of the ESA. In order to avoid this, the Plan Team suggests that measures be adopted to reduce the bycatch of birds. Populations of other species are not known to be affected adversely by fishing gear; however reducing overall seabird bycatch also would minimize the chance of future population problems in these species.

Steller Sea Lion Decline -- The Plan Teams identified several fishery concerns relevant to the continuing decline of Steller sea lions in the BSAI and GOA. One was diet diversity of sea lions. Discussion included within this report suggests that sea lions need a variety of prey available, perhaps as a buffer to significant changes in abundance of any single prey. The need to maintain a variety of prey for sea lions was the rationale for the BSAI Plan Team proposing that the AI pollock fishery be constrained as a bycatch only fishery. Atka mackerel in the Aleutian Islands area is the primary summer prey for sea lions in the area. As the sea lion population is continuing to decline in the Aleutian Islands, the Council should also consider sea lion concerns when setting a TAC for Atka mackerel for the Aleutian area.

Finally, the Plan Teams wishes to note that a variety of near shore and pelagic areas have been identified as important foraging habitat for a variety of marine mammal and seabird species. Three of these are of particular concern — Steller sea lions (threatened under the ESA), red-legged kittiwakes (a candidate species for threatened status), and northern fur seals (depleted under the MMPA). As the Council considers the BSAI pollock allocation this year, concerns for the health of the populations of these and other species' foraging habitats should also be considered.

Seabird, Marine Mammal, and Fish Species listed under the ESA -- There is a listing of the species that are designated as threatened or endangered under the ESA in a later section of this report. In addition to listing species under the ESA, the critical habitat of a species must be designated concurrent with its listing to the "maximum extent prudent and determinable". In compliance with this require of the ESA, NMFS has designated critical habitats for the Steller sea lion on August 27, 1993. These critical habitats include all rookeries, major haul-outs, and specific aquatic foraging habitats of the BSAI and GOA. The designation of these critical habitats continues for the 1996 fishing year.

Federal agencies are also required to initiate Section 7 (ESA) consultations with NMFS or USFWS for their actions (e.g., FMPs, regulatory measures, annual specifications of TACs) and make a determination as to whether the action may or may not affect endangered or threatened species. There were two such consultations made with the USFWS dated 3 July, 1989 and 7 February, 1995. The biological opinions of these consultations concluded that the groundfish fisheries of the BSAI and GOA would not jeopardize the existence of the endangered and threatened species of seabirds under the ESA.

Marine Mammal Potential Biological Removals -- The 1994 reauthorization of the MMPA provided for a long-term regime for managing marine mammal takes in commercial fisheries, replacing the Interim Exemption Program that had provided a general exemption on the MMPA take prohibition since 1988 for Alaska's groundfish fisheries. The cornerstone of the new regime is the calculation of Potential Biological Removals (PBRs) for each marine mammal stock. A list of the PBRs for all the marine mammal stocks off Alaska is contained in this document. The PBRs, the level of human caused mortality, and the overall status of the marine mammal stock are to be used to prioritize management of marine mammal/fisheries interactions.

The overall goal of the management regime is to eventually reduce the levels of marine mammal incidental takes to levels approaching zero. This goal requires a coordinated approach with fisheries management and may involve formation of Take Reduction Teams. For instance, a team may be formed to address all Alaskan marine mammals, including Stellar sea lions. Note, however, that current levels of marine mammal takes in the groundfish fisheries are already quite low. Subsistence takes exceeding PBRs will be approached through co-management.

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BIOLOGICAL FEATURES

Seabirds - by Vivian Mendenhall

Status and trophic relationships of seabirds

Alaska supports North America's greatest concentration of seabirds, owing to its productive marine waters and abundant nesting habitat. Approximately 50 million seabirds of 38 species nest in more than 1600 colonies (Figure 1). Alaskan seabirds are members of the orders Procellariiformes, Pelecaniformes, and Charadriiformes. These birds nest on steep seacoasts or remote islands and spend up to 80% of their lives at sea. Food is obtained at sea by picking prey from the surface or by diving and pursuing it underwater. Characteristics of seabird populations vary among species, but general features include delayed maturity (breeding starts at 2 to 9 years of age), long life (annual adult survival rates are 0.80-0.96), and low reproductive rates (approximately 0.2-1.5 young fledged annually). Seabird species, including Latin names, are listed in Tables 1-2.

Status.--Seabirds have been studied in the Bering Sea and Gulf of Alaska since the early 1970's. The location, species composition, and approximate size of breeding colonies are stored in a database at the U.S. Fish and Wildlife Service (USFWS) in Anchorage. There are approximately 36 million breeding seabirds at 470 colonies in the BS/AI and 12 million birds at 20,000 colonies in the GOA (Figure 1, Table 1). In addition, up to 50 million shearwaters and 3 albatross species feed in Alaskan waters but breed elsewhere (Table 2).

Population trends and productivity are monitored by USFWS every 1 to 3 years at approximately 6 colonies in each area. The species monitored are Common and Thick-billed Murres, Red-legged and Black-legged Kittiwakes, Northern Fulmar, Tufted Puffin, Fork-tailed and Leach's Storm-petrel, and Red-faced and Pelagic Cormorant. Diets also are monitored in some studies. Populations of marine seabirds are monitored on the water along parts of Kodiak Island and in Prince William Sound (PWS) and Cook Inlet.

Some seabird populations in the Bering Sea/Aleutian Islands and Gulf of Alaska regions have declined during part or all of the past 2 decades. Most declines were concentrated on islands of the southeastern Bering Sea and in the northern Gulf of Alaska. The principal colony of the Red-legged Kittiwake on St. George Island has declined by 50% during the past 20 years (Hatch et al. 1993); other species on the Pribilofs, including Red-faced Cormorants, Black-legged Kittiwakes, and murres, have declined to a lesser extent (Climo 1993, Dragoo and Sundseth 1993). In the northern Gulf of Alaska, declines have been documented in Black-legged Kittiwakes, murres, Pigeon Guillemots, and Marbled Murrelets) (Hatch et al. 1993, Klosiewski and Laing 1994, Kuletz 1996, Oakley and Kuletz 1996, Piatt and Anderson 1996). These declines probably began before the *Exxon Valdez* oil spill. Populations in other areas, including the AI, generally have been stable or have increased (reviewed in Hatch and Piatt 1995, Francis et al. 1996).

One seabird species that enters Alaskan waters, the Short-tailed Albatross, is endangered. The entire world population in 1995 was estimated as 800 birds; 350 adults breed on two small islands near Japan (H. Hasegawa, pers. comm.). The population is growing but is still critically endangered because of its small size and restricted breeding range. NMFS has consulted with USFWS concerning possible impacts on Short-tailed Albatross populations of groundfish fisheries, as required by the Endangered Species Act. USFWS has issued a Biological Opinion that permits a small incidental take of Short-tailed Albatrosses (as of October 1996, the permitted take is 2 birds per year.) Bycatch of albatrosses is discussed further below.

Most population trends in high-latitude seabirds have been associated with changes in food availability (Birkhead and Furness 1985, Piatt and Anderson 1996). The most serious non-food threat to seabird populations in Alaska has been (and remains) the introduction of alien predators, both foxes (Bailey 1993) and rats from vessels (Loy 1993). Human activities that have reduced populations elsewhere, but whose impacts have been minor so far in Alaska, include logging of old-growth forests (Mendenhall 1992), mining, coastal development, and recreational disturbance (Herter and Koski 1988). Oil spills may cause declines in some colonies, but even the *Exxon Valdez* spill may have affected populations less than changes in food supply and habitat (Hatch and Piatt 1995, Piatt and Anderson 1996).

Trophic relationships.--Forage fish are the principal diet of more than two thirds of Alaskan seabirds (Table 1A). The only seabird species that do not depend on fish during the breeding season are very small ones such as auklets (*Aethia* spp.; Table 1). The four seabirds that commonly visit Alaskan waters during their nonbreeding season also depend on forage fish here (Table 2). Capelin and sandlance are crucial to many bird species; other forage fish include Myctophids, herring, Pacific saury, and walleye pollock (Tables 1, 2). Many seabirds can subsist on a variety of invertebrates and fish during nonbreeding months but can only raise their nestlings on forage fish (Sanger 1987a, Vermeer et al. 1987).

Seabird population trends are largely determined by forage fish availability (Birkhead and Furness 1985). Although seabirds are adapted to occasional years of poor reproduction, a long-term scarcity of forage fish leads to population declines, usually through breeding failure rather than adult mortality. Breeding failure can result when adults lack sufficient energy reserves to complete a nest, lay eggs, or complete incubation, or when they cannot feed the nestlings adequately (e.g., Kuletz 1983, Baird 1990, Murphy et al. 1984, 1987, Springer 1991).
Seabirds depend on forage fish that are small (5 to 20 cm), high in energy content, and form schools within efficient foraging range of the breeding colony. Foraging distances range from 20 km or less for inshore feeders such as terns, guillemots, and cormorants to 60 km or farther for kittiwakes and murres (Schneider and Hunt 1984). Seabirds such as kittiwakes and terns can take prey only when they are concentrated at the surface; these species are affected more frequently by food shortage than are diving seabirds such as murres, murrelets, puffins, and cormorants.

Although Alaskan seabirds consume several species of fish, only one or two forage species are available near most colonies. If an important fish stock is depleted locally, birds may have no alternative that can support successful breeding. Regional variations in dominant forage fish include sandlance along most of the Aleutians and most parts of the Bering Sea (Springer 1991, Springer et al. 1996); capelin and walleye pollock on most of the Alaska Peninsula (Springer 1991, Hatch and Sanger 1992); and pollock and formerly capelin on St. Matthew Island and the Pribilof Islands (Hunt et al. 1981a, b, Springer et al. 1986, Decker 1995). The preferred forage species in each area usually is essential for successful seabird reproduction (Springer et al. 1986, 1987, Baird 1990, Piatt and Anderson 1996). Capelin have increased again near some GOA colonies since 1994, and kittiwake breeding success has improved there recently (D.B. Irons, pers. comm.).

Interactions of seabirds and fisheries.--Fisheries and seabirds interact through populations of fish and through contact of birds with fishing gear. Competition between seabirds and fisheries for forage fish is difficult to evaluate. Climatic fluctuations undoubtedly contribute to fluctuations in seabird food resources (Wooster 1993,), but fisheries also may do so (Duffy 1983, Steele 1991). Pollock are the only food species of Alaskan seabirds for which there is a large directed fishery. The fishery may have impacted this food source by temporarily depleting local forage concentrations on which breeding birds depend near their colonies (Francis et al. 1996). There may also have been indirect ecosystem effects on other forage species (Francis et al. 1996, Piatt and Anderson 1996).

Fisheries and seabirds may interact through the food chain in other ways. Fish processing provides food directly to scavenging species such as Northern Fulmars and large gulls. This can benefit populations of some species, but it can be detrimental to others which they may displace or prey upon (Furness and Ainley 1984). Predation by birds has impacts on fish populations that have variously been estimated as minor to significant (reviewed by Croxall 1987).

Seabirds are caught incidentally to all types of fishing operations, but the vulnerability of bird species to gear types differs with feeding ecology. Longlines catch surface-feeding seabirds that are attempting to capture baits as the line is being set; some birds are caught on hooks and drown. Trawls appear to catch birds that are scavenging fragments of fish as the net is being hauled. Gillnets catch both scavengers at the surface, and diving birds as they are foraging alongside the target fish. Bird bycatch in Alaskan waters were first examined for the Japanese mothership gillnet salmon fishery (DeGange et al. 1993). Bycatch in inshore salmon gillnets was reported by Wynne et al. (1991, 1992). Catch of birds in seines has been reported anecdotally but never investigated.

Bycatch of seabirds by groundfish fisheries has been monitored by fishery observers since 1990. In 1990-1992 they reported only "bird"; since 1993, observers have been trained by USFWS identify birds to genus or species. Birds found in the observers' random samples are reported on standard bycatch forms. Bird bycatch that is outside the regular samples, including birds that are caught in gear or collide with the rigging, also are reported. The emphasis in non-sample reports is on species of concern, such as albatrosses. Data on birds are processed by NMFS and relayed to USFWS.

Bird bycatch data have been summarized in a preliminary fashion only for 1990-1993 (as of October 1996). The estimated average annual mortality in all groundfish fisheries during this period was 9,600 birds (Table 3). Longlines caught the great majority of the birds. The longline data do not include the halibut fishery, for which no data are available. In 1993 the principal species caught in longline gear was the Northern Fulmar (estimated at 3,819 in the BS/AI and 2,021 in the GOA). Laysan albatrosses (492 and 416) were next, and then members of the genus *Larus* (gulls; 740 and 96). Trawls caught mostly unidentified shearwaters or petrels (137 in the BS/AI, 65 in the GOA) and unidentified small auks (murrelets or auklets; 64 in the BS/AI, none in the GOA). Coefficients of variation are not yet available for these data.

Three Short-tailed Albatrosses have been reported caught in the longline fishery since 1990: two in 1995 and one in October 1996. Both 1995 birds were caught in the vicinity of Unimak Pass and were taken outside the observers' statistical samples. No information is available yet (as of 8 October 1996) on the most recent incident. USFWS, NMFS, and the Biological Resources Division (formerly National Biological Service) are cooperating to evaluate the degree to which bycatch may affect the recovery of the Short-tailed Albatross from its critically endangered status.

Measures to deter birds from approaching longline gear are deployed by some Alaskan fishermen, both out of concern for welfare of the birds and to reduce the rate at which the birds steal bait. Some skippers add weight to lines to ensure that bait sinks quickly out of the birds' reach. Efforts to scare birds away from baits include towing a buoy astern and suspending streamers above the wake. NMFS and USFWS are working with fishers to provide information on deterrent measures and to expand their use. Conservation organizations have recently expressed concern about bird bycatch, particularly of albatrosses.

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Table 1.--Estimated populations and principal diets of seabirds that breed in the Bering Sea/Aleutian Islands (BS/AI) and Gulf of Alaska (GOA) regions. Footnotes follow Table 1B.

Species	Population[1,2] BS/AI	GOA	Diet[3,4]
Northern Fulmar (*Fulmarus glacialis*)	1.500,000	600,000	Q,M,F,Z,I
Fork-tailed Storm-Petrel (*Oceanodroma furcata*)	4,500,000	1,200,000	Q,Z, C
Leach's Storm-Petrel (*Oceanodroma leucorrhoa*)	4,500,000	1,500,000	Q,Z
Double-crested Cormorant (*Phalacrocorax auritis*)[5]	9,000	8,000	F,I
Pelagic Cormorant (*Phalacrocorax pelagicus*)	80,000	70,000	S,C,P,H,F,I
Red-faced Cormorant (*Phalacrocorax urile*)	90,000	40,000	C,S,H,F,I
Brandt's Cormorant (*Phalacrocorax penicillatus*)	0	100	?
Pomarine Jaeger (*Stercorarius pomarinus*)	Common	Common	C,S
Parasitic Jaeger (*Stercorarius parasiticus*)	Common	Common	C,S
Long-tailed Jaeger (*Stercorarius longicaudus*)	Common	Common	C,S
Bonaparte's Gull (*Larus philadelphia*)	Rare	Common	?
Mew Gull (*Larus canus*)[5]	700	40,000	C,S,I
Herring Gull (*Larus argentatus*)[5]	50	300	C,S,H,F,I,D
Glaucous-winged Gull (*Larus glaucescens*)	150,000	300,000	C,S,H,F,I,D
Glaucous Gull (*Larus hyperboreus*)[5]	30,000	2,000	C,S,H,I,D
Black-legged Kittiwake (*Rissa tridactyla*)	800,000	1,000,000	C,S,P,M,Z
Red-legged Kittiwake (*Rissa brevirostris*)	150,000	0	M,C,S,P,Z
Sabine's Gull (*Xema sabini*)	Common	Common	?
Arctic Tern (*Sterna paradisaea*)[5]	7,000	20,000	C,S,Z,F
Aleutian Tern (*Sterna aleutica*)	9,000	25,000	C,S,Z,F
Common Murre (*Uria aalge*)	3,000,000	2,000,000	C,S,P,H,F
Thick-billed Murre (*Uria lomvia*)	5,000,000	200,000	C,S,P,Q,Z,M,F,I
Pigeon Guillemot (*Cepphus columba*)	100,000	100,000	S,C,F,H,I
Marbled Murrelet (*Brachyramphus marmoratus*)	Uncommon	Common	C,S,P,F,Z,I
Kittlitz's Murrelet (*Brachyramphus brevirostris*)	Uncommon	Uncommon	S,C,H,P,F,Z,I
Ancient Murrelet (*Synthliboramphus antiquus*)	200,000	600,000	Z,F,C,S,P,I
Cassin's Auklet (*Ptychoramphus aleuticus*)	250,000	750,000	Z,Q,S,F,I
Least Auklet (*Aethia pusilla*)	9,000,000	50	Z,I
Parakeet Auklet (*Cyclorrhynchus psittacula*)	800,000	150,000	F,S,P,Z,I
Whiskered Auklet (*Aethia pygmaea*)	30,000	0	Z,I
Crested Auklet (*Aethia cristatella*)	3,000,000	50,000	Z,I
Rhinoceros Auklet (*Cerorhinca monocerata*)	50	200,000	C,S,H,A,F
Tufted Puffin (*Fratercula cirrhata*)	2,500,000	1,500,000	C,S,P,F,Q,Z,I
Horned Puffin (*Fratercula corniculata*)	500,000	1,500,000	C,S,P,F,Q,Z,I
Total	36,000,000	12,000,000	

Table 2.--Comparative population estimates and diets of non-breeding seabirds that frequent the Bering Sea/Aleutian Islands and Gulf of Alaska regions.

Species	Population[2] BS/AI	GOA	Diet[3,4]
Short-tailed Albatross (*Diomedea albatrus*)	Rare	Rare	?
Black-footed Albatross (*Diomedea nigripes*)	Common	Common	M,F,Q,I,D
Laysan Albatross (*Diomedea immutabilis*)	Common	Common	M,Q,I,F
Sooty Shearwater (*Puffinus griseus*)	Common	Abundant	M,A,C,S,Q,F,Z
Short-tailed Shearwater (*Puffinus tenuirostris*)	Abundant	Common	M,A,Z, C,S,F
Ivory Gull (*Pagophila eburnea*)	Uncommon	0	?

[1] Source of population data for colonial seabirds that breed in coastal colonies: modified from U.S. Fish and Wildlife Service 1996. Estimates are minima, especially for storm-petrels, auklets, and puffins.

[2] Numerical estimates are not available for species that do not breed in coastal colonies. Approximate numbers: abundant $\geq 10^6$; common = 10^5-10^6; uncommon = 10^3-10^5; rare $\leq 10^3$.

[3] Abbreviations of diet components: M, Myctophid; P, walleye pollock; C, capelin; S, sandlance; H, herring; A, Pacific saury; F, other fish; Q, squid; Z, zooplankton; I, other invertebrates; D, detritus; ?: no information for Alaska. Diet components are listed in approximate order of importance. However, diets depend on availability and usually are dominated by one or a few items (see text).

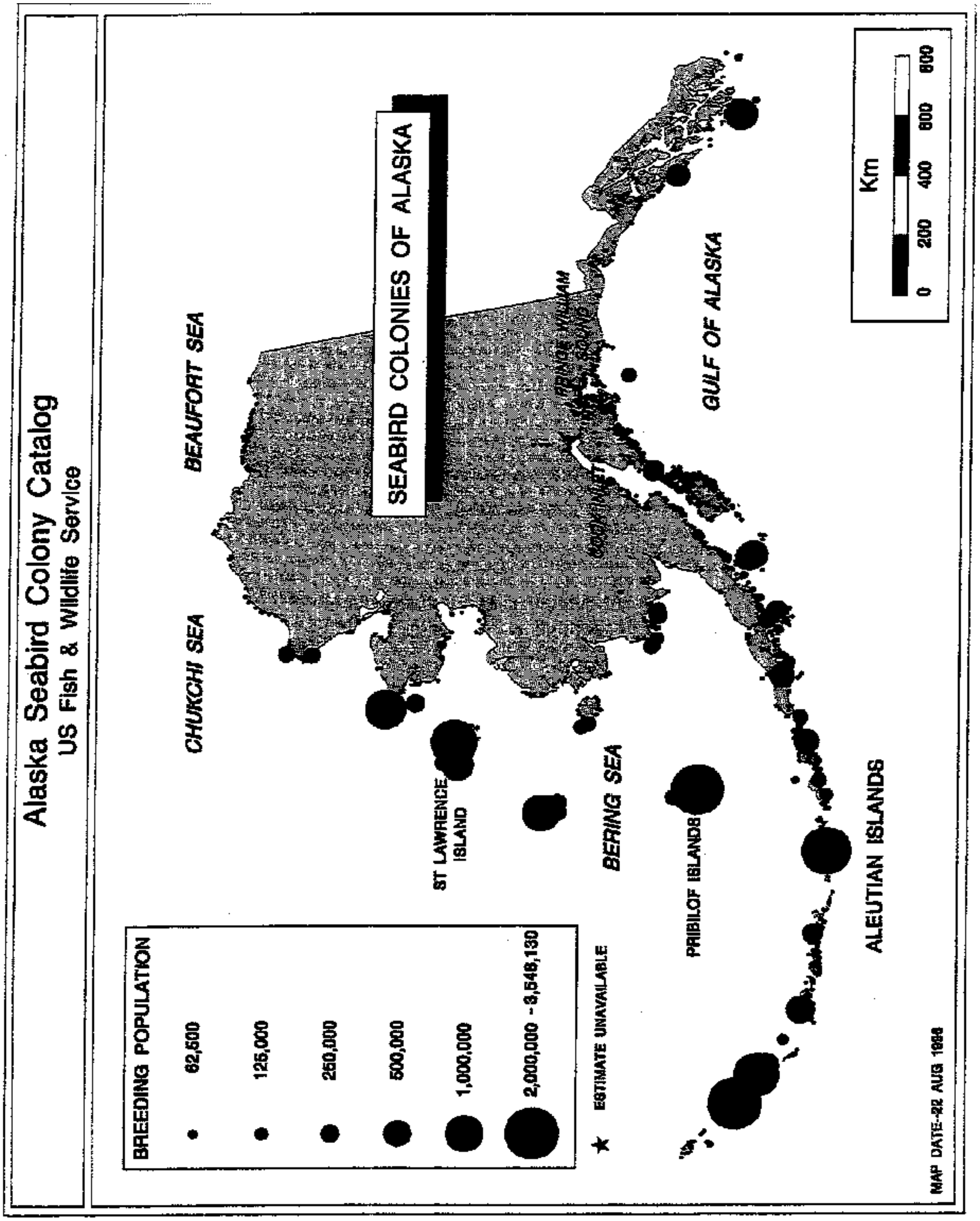
[4] Sources of diet data: Ainley and Sanger 1979, Baird and Gould 1986, Bedard 1969, DeGange and Sanger 1986, P.J. Gould (pers. comm.), Gould et al. (in press), Hatch 1984, 1993, Hatch and Sanger 1992, Hunt et al. 1981a, b, c, Irons et al. 1986, Kuletz 1983, Murphy et al. 1984, 1987, Ogi 1984, Ogi and Tsujita 1973, Patten and Patten 1982, Sanger 1986, 1987a, b, Schneider and Hunt 1984, Springer et al. 1986, 1987, 1996, Vermeer et al. 1987, Vermeer and Westrheim 1984, Wehle 1982.

[5] Species breeds both coastally and inland; population estimate is only for coastal colonies.

Table 3.--Estimated average bycatch of seabirds in Alaskan groundfish fisheries, 1990-1993. Data for trawl fisheries (domestic only) from 1989-1993. Source: Wohl et al. 1995.

Fishery	Observer effort (days)	Range of % catch monitored	Estimated average annual mortality
BS/AI Groundfish			
Longline	15,932	64-80	7,250
Pot	1,603	43-64	10
Trawl	48,378	49-69	910
GOA Groundfish			
Longline	3,704	13-27	1,420
Pot	814	3-11	0
Trawl	9,714	5-45	10
Total			9,600

Figure 1. Location of seabird colonies in Alaska.



Marine Mammals - by Richard Merrick and Rich Ferrero

Status of Harbor Seals - Minimum population estimates were obtained for harbor seals, Phoca vitulina richardsi, along the north side of the Alaska Peninsula and Bristol Bay/Togiak National Wildlife Refuge during August/September molt surveys in 1995. The mean number of seals along the north side of the Alaska Peninsula was 7,785 with a CV of the mean equal to 4.4%. The number of seals in Bristol Bay was 955 with a CV equal to 7.1 %. The unusually large counts from surveys conducted in 1976 were re-examined and found to be correct as initially reported. The number of seals along the north side of the Alaska Peninsula , therefore, appear to have been reduced to 42% of the 1975 census figures, which represents a decline of 3.475% per year. The seals in Bristol Bay have also been significantly reduced. Counts have remained low, but steady since 1990.

Status of Steller Sea Lions -- On 4 October 1995, the NMFS published a proposal in the Federal Register (60 FR 51968) to list the western population[1] of the U.S. Steller sea lion population as endangered under the Endangered Species Act, and to retain the threatened status for the eastern population[2]. A final rule is scheduled to be issued in October-November of 1996.

As part of the evaluation of Steller sea lion status, the NMFS will review all management actions enacted to conserve the U.S. population. A list of proposed actions affecting the Alaskan sea lion population will be presented to the Council at the December 1996 meeting. NMFS will then consult with representatives of the native, industry, and environmental communities, Steller sea lion Recovery Team, Alaska State government, and other interested parties with the intent of developing an amendment analysis for submission to the Council during fall 1997.

NMFS and ADF&G conducted an aerial survey (using similar protocols to past summer surveys) during the period of 10-24 June 1996 in the area from SE Alaska westward through Attu Island in the western Aleutian Islands. An overall decrease of 7.8% (from 32,930 to 30,348) since 1994 was observed in non-pup numbers at trend sites in Alaska (Table 1). Since 1994, numbers have decreased in Southeast Alaska (-7.2%, from 8,811 to 8,181 non-pups) and in the Gulf of Alaska (-17.6%, from 11,871 to 9,782), but not in the Aleutian Islands as a whole (+1.1%, from 12,248 to 12,385). Kenai-Kiska area trend site sea lion numbers decreased by 4.6% (from 18,713 to 17,847).

The increase in numbers in the eastern Aleutian Islands (+6.6, Table 4) was notable because it affirms observations since 1990 that the sea lion population has stabilized there, particularly in the Krenitzen Islands to Unimak Island area (which increased from 1992 to 1994 despite a decrease in the larger eastern Aleutian Islands area). Declines in Southeast Alaska sea lion numbers may be a result of normal interannual variability, but will be watched closely in the future.

NMFS and ADF&G also conducted a partial survey of Steller sea lion pups at nine rookeries in the area from Southeast Alaska to the eastern Aleutian Islands during 24 June - 14 July 1996. Since 1994, pup numbers have decreased by 6.1% (from 6,494 pups to 6,098; Table 5) at the sites counted. Patterns of decrease were similar to those observed for the non-pups--the greatest decreases were observed in the eastern Gulf of Alaska (-37.5%, from 903 to 564), while numbers increased at the single site counted in the eastern Aleutian Islands (+23.3% at Ugamak Island).

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[1] Those Steller sea lions found west of 144° W longitude in US waters.

[2] Those Steller sea lions found east of 144° W longitude in SE Alaska, Washington, Oregon, California.

Table 4. Counts of adult and juvenile Steller sea lions observed at rookery and haulout trend sites in seven areas of Alaska during June aerial surveys in 1992, 1994, and 1996[3].

Area	Count			Percent change	
	1992	1994	1996	1992-94	1994-96
SE Alaska	7,558	8,811	8,181	16.6	-7.2
Gulf of Alaska					
Eastern (PWS)	3,738	3,369	2,131	-9.9	-36.8
Central	5,721	4,520	3,913	-21.0	-13.4
Western	3,720	3,982	3,738	7.0	-6.1
Total GOA	13,179	11,871	9,782	-10.1	-17.6
Aleutian Islands					
Eastern	4,839	4,421	4,714	-8.6	6.6
Central	6,399	5,790	5,482	-9.5	-5.3
Western	2,869	2,037	2,189	-29.0	7.5
Total AI	14,107	12,248	12,385	-13.2	1.1
Kenai-Kiska	20,679	18,713	17,847	-9.5	-4.6
Alaska Total	34,844	32,930	30,448	-5.5	-7.8

[3] These are interim counts and are subject to some changes.

Table 5. Counts of live Steller sea lion pups observed at rookeries in Alaska during June-July 1994 and 1996.

Rookery	Count of live pups		Percent change
	1994	1996	
SE Alaska			
Forrester Complex	2,757	2,764	0.3%
Hazy Island	862	768	-10.9%
White Sisters	151	182	20.5%
Eastern GOA			
Seal Rocks	598	332	-44.5%
Fish Island	305	232	-23.9%
Central GOA			
Outer I.	119	114	-4.2%
Marmot I.	804	632	-21.4%
Western GOA			
Atkins I.	324	366	13.0%
Eastern Aleutian I.			
Ugamak I.	574	706	23.0%
Total	6,494	6,096	-6.1%

ENDANGERED SPECIES ACT AND MARINE MAMMAL PROTECTION ACT CONSIDERATIONS

by Richard Merrick and Rich Ferrero

Endangered Species Act - The Endangered Species Act (ESA) provides for the conservation of endangered and threatened species of fish, wildlife and plants. The program is administered jointly by the Department of Commerce (NMFS) for most marine species, and the Department of Interior (USF&WS) for terrestrial and freshwater species.

The ESA procedure for identifying or listing imperiled species involves a two-tiered process, classifying species as either threatened or endangered, based on the biological health of a species. Threatened species are those likely to become endangered in the foreseeable future [(16 U.S.C. §1532(20)]. Endangered species are those in danger of becoming extinct throughout all or a significant portion of their range [16 U.S.C. §1532(20)]. The Secretary of Commerce, acting through the NMFS, is authorized to list marine mammal and fish species. The Secretary of Interior, acting through the USFWS, is authorized to list all other organisms.

The following species are currently listed as endangered under the ESA and are present in the BSAI and GOA management areas:

Bowhead whale	Balaena mysticetus	(Bering Sea)
Northern right whale	Balaena glacialis	
Sei whale	Balaenoptera borealis	
Blue whale	Balaenoptera musculus	
Fin whale	Balaenoptera physalus	
Humpback whale	Megaptera novaeangliae	
Sperm whale	Physeter macrocephalus	
Snake River sockeye salmon	Oncorhynchus nerka	
Short-tailed albatross	Diomedea albatrus	

Threatened species found in the BS/AI or GOA include:

Steller sea lion	Eumetopias jubatus (proposed as Endangered west of Cape Suckling)
Snake River spring/summer chinook salmon	Oncorhynchus tshawytscha
Snake River fall chinook salmon	Oncorhynchus tshawytscha
Spectacled eider	Somateria fischeri

In addition to listing species under the ESA, the critical habitat of a species must be designated concurrent with its listing to the "maximum extent prudent and determinable" [16 U.S.C. §1533(b)(1)(A)]. The ESA defines critical habitat as those specific areas that are essential to the conservation of a listed species and that may be in need of special consideration. Where appropriate, critical habitat can also be designated for threatened and endangered species. In compliance with the requirements of the ESA, NMFS designated critical habitat for the Steller sea lion on August 27, 1993. The Steller sea lion critical habitat designation does not place any additional restrictions on human activities within designated areas. For Steller sea lions, NMFS has designated critical habitats that are essential for reproduction, rest, refuge, and feeding. These critical habitats in Alaska include all rookeries, major haul-outs, and specific aquatic foraging habitats of the BSAI and GOA (58 FR 45278, August 27, 1993). The primary benefit of critical habitat designation is that it informs Federal agencies that Steller sea lions are dependent upon these areas for their continued existence, and that consultation with NMFS on any Federal action that may affect these areas is required.

Federal agencies are required to initiate Section 7 (ESA) consultations with NMFS or USFWS for their actions (e.g., Fishery Management Plans, regulatory measures, annual specifications for total allowable catches) and make a determination as to whether the action may or may not affect endangered or threatened species. Typically, the consultation begins with an informal consultation. If the informal consultation concludes that the action "is not likely to adversely affect" endangered or threatened species or critical habitat, and the appropriate agency (NMFS or USFWS) concurs with that determination, the consultation requirements are satisfied and formal consultation is not required. Except for listed Pacific salmon, the appropriate Regional Director is authorized to sign informal consultations.

If the action is determined as "likely to adversely affect" endangered or threatened species or critical habitat, then formal consultation is required. Formal consultations are necessary on actions that may affect endangered or threatened species and critical habitat if a "taking"[4] may occur. In the case of federally authorized fisheries actions, formal consultation is initiated and conducted by NMFS, and the resulting biological opinion is issued to NMFS.

Fishery Management Councils may be invited to participate in the compilation, review, and analysis of data used in the consultation. The ESA also allows private individuals to petition to list or change the status of a species [16 U.S.C. § 1533(b)3)A)]. Also considered, are the economic impacts in critical habitat designation decisions. However, the determination of whether the action "is likely to jeopardize the continued existence of" endangered or threatened species or to result in the destruction or modification of critical habitat is the responsibility of the appropriate agency (NMFS or USFWS). If the action is determined to result in jeopardy, the opinion will include reasonable and prudent measures that are necessary to alter the action so that jeopardy is avoided. If an incidental take of a listed species will occur, an incidental take statement will be appended to the biological opinion. Only the Assistant Administrator for Fisheries, NOAA, is authorized to sign NMFS biological opinions. Once the Opinion is issued, the appropriate Regional Director will advise the Fisheries Management Council of actions that should or must be taken relative to the fishery management program to be in compliance with the biological opinion. The status of Section 7 consultations for listed species is provided below.

<u>Cetaceans</u>: Formal consultation on the effects of the GOA groundfish fishery on listed cetaceans was concluded on April 19, 1991. The biological opinion considered all aspects of the fishery and concluded that the fishery was unlikely to adversely affect listed cetaceans. The April 19, 1991 biological opinion on the effects of the BSAI groundfish fishery reiterated the conclusion of previous opinions that the BSAI fishery was unlikely to jeopardize listed cetaceans, including bowhead whales.

<u>Steller sea lions</u>: Formal consultation on the effects of GOA and BSAI groundfish fisheries on Steller sea lions was reinitiated in 1995. Biological opinions were completed in January 1996, and concluded that these fisheries and harvest levels are unlikely to jeopardize the continued existence and recovery of the Steller sea lion or adversely modify critical habitat.

<u>Seabirds</u>: Formal consultation on the effects of BSAI and GOA groundfish fisheries was concluded on July 3, 1989. That consultation concluded that these fisheries would adversely affect the short-tailed albatross and

[4] The term "take" under the ESA means "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct" (16 U.S.C. §1538(a)(1)(B).

would result in the incidental take of up to two birds per year, but would not jeopardize the continued existence of that species. Subsequently, informal consultations made in 1992, 1993, 1994, and 1995 concluded that no additional adverse impacts beyond those aforementioned formal consultation would occur. Following the take of a short-tailed albatross in August 1995, consultation on BSAI and GOA TAC specifications have been re-initiated each year. Allowable take will be held at 2 birds for the 1997 TAC specifications.

Salmon: Effects of the GOA and BSAI groundfish fisheries on listed salmon were considered by informal consultations in 1992 and 1993. These consultations concluded that salmon species listed under the ESA were not likely to be adversely affected by TAC specifications, or by a change in the non-roe pollock fishing season in the BSAI. Formal consultations were done for GOA and BSAI TAC specifications in 1994 and subsequent years. A biological opinion issued in December 1995 concluded that groundfish fisheries are not likely to jeopardize listed salmon species for a bycatch of less than 55,000 salmon.

Marine Mammal Protection Act - Since the reauthorization of the Marine Mammal Protection Act (MMPA) on April 30, 1994 several key provisions effecting commercial fisherman have been implemented or proposed. The 1994 amendments to the MMPA provide for a new long-term regime for managing marine mammal takes in commercial fisheries, replacing the Interim Exemption Program that had provided a general exemption on the MMPA take prohibition since 1988. Implementation is essentially complete. The various steps in the process are presented in the accompanying flow diagram while a summary of highlights is provided below.

The cornerstone of the new regime has been the development of Stock Assessment Reports for every marine mammal stock found in U.S. waters. These reports are available annually. For each species the report details the stock definitions and geographic ranges, the most current population size estimates, productivity rates, calculation of the Potential Biological Removals (PBR) (the product of a minimum population estimate, a fraction of the maximum net productivity rate (0.02 for cetaceans and 0.08 for pinnipeds) and a safety factor (ranging from 0.1 to 1.0), annual human-caused mortality, and status of the stock. Regional Scientific Review Groups (SRGs) were established to provide recommendations and guidance on the assessment reports. These groups will remain in place to provide comment and review as necessary.

Table 6 contains the draft 1996/97 PBRs for Alaskan marine mammal stocks, as well as the data used to calculate the values and the prioritization level assigned for each stock. The PBRs, the level of human caused mortality and the overall status of the stock were used to prioritize management of marine mammal/fisheries interactions. This step identifies “strategic” and “non-strategic” stocks. Stocks for which total human-caused mortality exceeds the PBR, or which are listed as threatened or endangered (under the Endangered Species Act) or depleted (under MMPA) are said to be "strategic." [Of the strategic stocks in Alaska, Steller sea lion, northern fur seal, and harbor seal are occasionally taken in commercial fisheries.]

The short term management goal is to reduce human caused mortality of strategic stocks below their PBRs, while the long term goal is for all fisheries to meet their “zero mortality goal” by April 2001. Under the currently proposed definition, the “zero mortality goal” would be met when total fishery mortality (all fisheries) is less than 10% of the stock’s PBR, or in cases where total fishery mortality is above 10%, no individual fishery is removes more than 1% of the stock’s PBR.

The MMPA goal of reducing incidental takes in commercial fisheries to levels approaching zero requires a coordinated approach with industry participation. This concern is expressed in the MMPA provisions for the formation of Take Reduction Teams and development of Take Reduction Plans. Where PBRs are exceeded, Take Reduction Teams will formulate strategies to reduce takes; fisheries closures are not automatically invoked when PBRs are exceeded.

All commercial fisheries are classified with respect to their impacts on marine mammals. Under the old Interim Exemption Program, fisheries were categorized according to whether the fishery had frequent, occasional or remote likelihood of taking marine mammals, whereas the current regulations define the categories in terms of the percent of the PBR a particular fishery or fisheries annually removes. Observer data are used to determine take levels whenever available, while logbooks, confirmed fisher's reports etc. are used to establish minimum levels for fisheries not monitored. For placement in Category I, a fishery would take 50% or more of the PBR by itself; Category II would be assigned to all fisheries which combined were responsible for over 10% of a stock's PBR and where individually they accounted for 1 to 50% of a PBR; Category III would be assigned to all fisheries responsible for less than 10% of a PBR, provided that no individual vessel is responsible for removing more than 1% of a PBR. All federally managed groundfish fisheries in Alaska are currently listed in Category III.

Under the old Interim Exemption Program, vessels in Categories I and II were required to report marine mammal incidental takes via logbooks, however, the new program replaced logbooks with postcard data forms which are sent to NMFS after completion of trips where marine mammal takes occurred. This requirement will apply to all categories of fisheries. Observer monitoring provisions have been retained for Categories I and II, while a Category III fishery may also be monitored if a take problem is identified. Fisheries taking ESA-listed species will be required to obtain a separate authorization to take them.

The 1994 amendments placed a prohibition on the intentional taking of marine mammals in commercial fishing operations except when the threat of human injury or death exists. Intentional takes occurred commonly in some fisheries that regularly interacted with harbor seals. The final rule on the provision was published in the Federal Register on February 1, 1995 and took effect 30 days later (3/3/95).

Stock Summary Table. 1

Species	Stock	N (est)	CV	C.F.	CV C.F.	Comb. CV	N(min)	0.5 Rmax	F(r)	PBR	Fishery mort.	Subsist mort.	Status
Baird's beaked whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	see txt	NS
Bearded seal	Alaska	n/a					n/a	0.06	0.50	n/a	2	n/a	NS
Beluga whale	Beaufort Sea	42,566	0.103	2.00	n/a	0.103	39,039	0.02	1.00	781	0	168	NS
Beluga whale	Eastern Chukchi Sea	3,710	n/a	3.09	n/a	n/a	3,710	0.02	1.00	74	0	63	NS
Beluga whale	Norton Sound	7,986	0.26	3.09	n/a	see txt	6,439	0.02	1.00	129	0*	109	NS
Beluga whale	Bristol Bay	1,555	n/a	3.09	n/a	n/a	1,526	0.02	1.00	31	1*	20	NS
Beluga whale	Cook Inlet	981	n/a	2.90	n/a	see txt	981	0.02	1.00	20	0*	40	S
Bowhead whale	Western Arctic	8,200	0.069			0.069	7,738	0.02	0.50	77	0	51	S
Cuvier's beaked whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
Dall's porpoise	Alaska	83,400	0.097			0.097	76,874	0.02	1.00	1,537	42	0	NS
Fin whale	Alaska	n/a					n/a	0.02	0.10	n/a	0	0	S
Gray whale	Eastern No Pacific	22,571	0.0524			0.0524	21,597	0.02	1.00	432	3	43	NS
Harbor porpoise	Southeast Alaska	10,301	see txt	see txt	see txt	see txt	8,156	0.02	0.50	82	4*	0	NS
Harbor porpoise	Gulf of Alaska	8,497	0.134	3.10	0.171	0.218	7,085	0.02	0.50	71	27	0	NS
Harbor porpoise	Bering Sea	10,946	0.243	3.10	0.171	0.300	8,549	0.02	0.50	86	2	0	NS
Harbor seal	Southeast Alaska	37,450	0.026	1.74	0.068	0.073	35,226	0.06	1.00	2,114	34*	1,596	NS
Harbor seal	Gulf of Alaska	23,504	0.028	1.50	0.047	0.056	22,427	0.06	0.50	673	35	931	S
Harbor seal	Bering Sea	13,312	0.062	1.50	0.047	see txt	12,648	0.06	0.50	379	30	212	NS

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Stock Summary Table (cont.) 1

Species	Stock	N (est)	CV	C.F.	CV C.F.	Comb. CV	N(min)	0.5 Rmax	F(r)	PBR	Fishery mort.	Subsist mort.	Status
Humpback whale	Western No Pacific	n/a					n/a	0.02	0.10	n/a	0	0	S
Humpback whale	Central No Pacific	1,407	0.107			see txt	1,407	0.02	0.10	2.8	1.6	0	S
Killer whale	Eastern No Pacific Northern resident	764	n/a			see txt	764	0.02	0.50	7.6	1.2	0	NS
Killer whale	Eastern No Pacific Transient	314	n/a				314	0.02	0.50	3.1	1.2	0	NS
Minke whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
Northern right whale	North Pacific	n/a					n/a	0.02	0.10	n/a	0	0	S
Northern fur seal	Eastern No Pacific	1,019,192	0.0593	4.475	n/a	0.0593	969,595	0.043	0.50	20,846	18	1713	S
Pac white-sided dolphin	North Pacific	931000	0.900				486,719	0.02	0.50	4,867	2	0	NS
Ribbon seal	Alaska	n/a					n/a	0.06	0.50	n/a	1	n/a	NS
Ringed seal	Alaska	n/a					n/a	0.06	0.50	n/a	1	n/a	NS
Sperm whale	Alaska	n/a					n/a	0.02	0.10	n/a	0	0	S
Spotted seal	Alaska	n/a					n/a	0.06	0.50	n/a	2*	see txt	NS
Stejneger's beaked whale	Alaska	n/a					n/a	0.02	0.50	n/a	0	0	NS
Steller sea lion	Eastern U. S.	23,900	0.0184	see txt	n/a	0.0184	23,533	0.06	0.75	1,059	5	4	S
Steller sea lion	Western U. S.	43,200	0.0184	see txt	n/a	0.0184	42,536	0.06	0.30	766	38	480	S

C.F. = correction factor; CV C.F. = CV of correction factor; Comb. CV = combined CV; Status: S=Strategic, NS=Not Strategic, n/a = not available
* = No reported take by NMFS observers; however, observer coverage was minimal or nonexistent
see txt = see text for details

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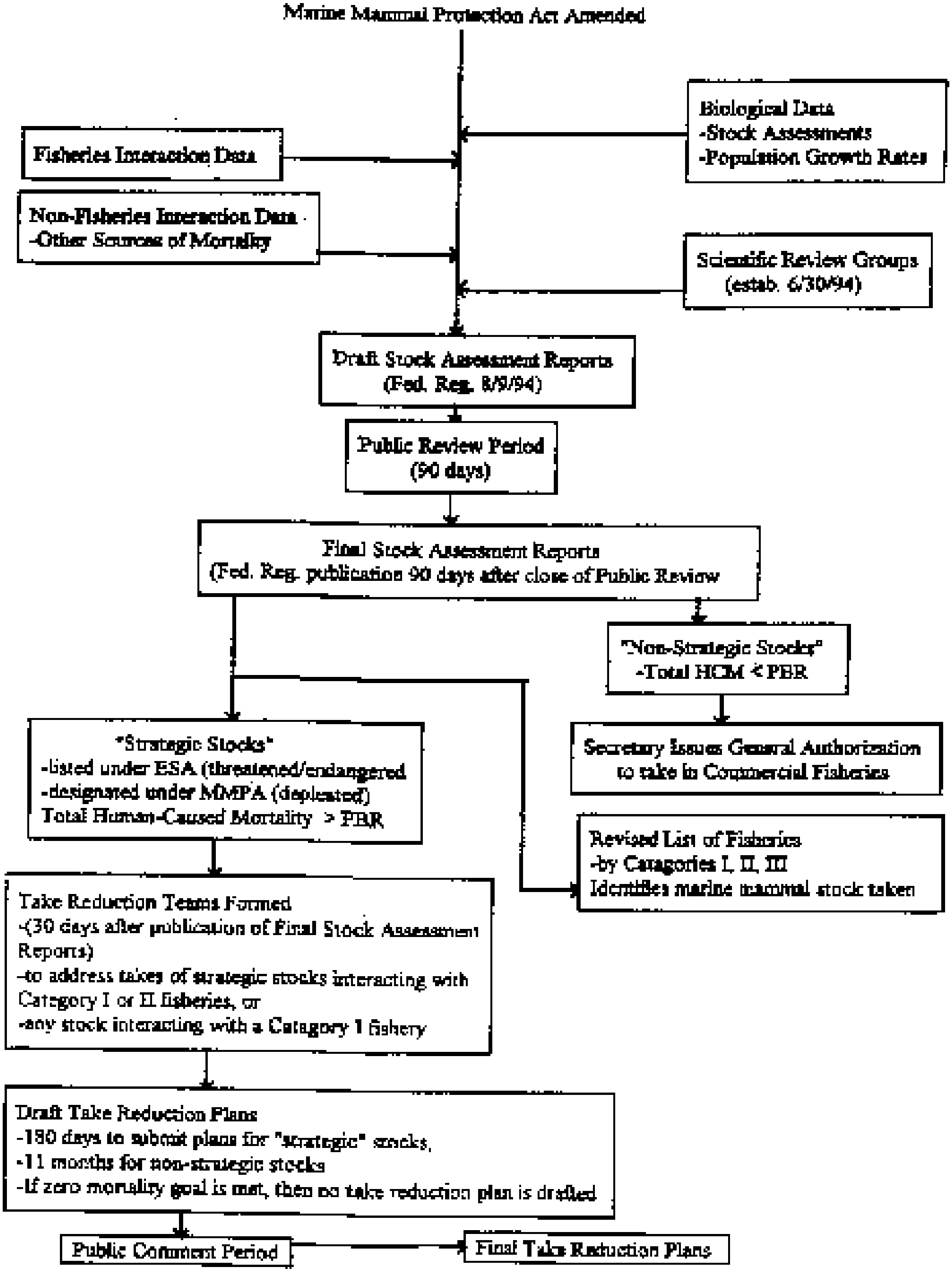
Marine Mammal Protection Act Amended
Fisheries Interaction Data
Non-Fisheries Interaction Data
-Other Sources of Mortality
Biological Data
-Stock Assessments
-Population Growth Rates
Scientific Review Groups
(estab. 6/30/94)
Draft Stock Assessment Reports
(Fed. Reg. 8/9/94)
Public Review Period
(90 days)
Final Stock Assessment Reports
(Fed. Reg. publication 90 days after close of Public Review
"Non-Strategic Stocks"
-Total HCM < PBR
Secretary Issues General Authorization
to take in Commercial Fisheries
"Strategic Stocks"
-listed under ESA (threatened/endangered
-designated under MMPA (depleted)
Total Human-Caused Mortality > PBR
Revised List of Fisheries
-by Catagories I, II, III
Identifies marine mammal stock taken
Take Reduction Teams Formed
-(30 days after publication of Final Stock Assessment Reports)
-to address takes of strategic stocks interacting with Category I or II fisheries, or
-any stock interacting with a Catagory I fishery
Draft Take Reduction Plans
-180 days to submit plans for "strategic" stocks,
-11 months for non-strategic stocks
-If zero mortality goal is met, then no take reduction plan is drafted
Public Comment Period
Final Take Reduction Plans

ECOSYSTEM CHANGE

by Richard Merrick

A major shift in the physical oceanography of the North Pacific Ocean occurred around 1976-77 (Kerr 1992; Francis and Hare 1994; Trenberth and Harrell 1995). In the subarctic North Pacific Ocean (the Bering Sea, Aleutian Islands, and Gulf of Alaska) this was manifested in increased sea surface temperatures (SST) and winds, which changed the mixed layer depth and intensified ocean transport (Royer 1989; Tabata 1989; Polovina et al. in press). Shifts between warm and cool eras appear to occur on a decadal or greater (e.g., 18.6 yr) frequency in the North Pacific Ocean (Royer 1989; Hollowed and Wooster 1992; Royer 1993; Trenberth and Harrell 1995; Wooster and Hollowed 1995).

Such shifts in physical conditions may also be associated with changes in ocean productivity. First, Venrick et al. (1987) have shown that primary production began to increase in the area north of the Hawaiian Islands around 1976-77, due to an apparent deepening of the mixed layer depth (Venrick 1995). Modeling of the phytoplankton response to the shoaling of the Gulf of Alaska mixed layer suggested that primary production had probably increased there as well (Polovina et al. in press). Next, Brodeur and Ware (1992) found that zooplankton production had doubled in the Gulf of Alaska between 1956-62 and 1980-89. They hypothesized that this was either because 1) primary production increased during 1980-89 from the increased Ekman pumping of nutrients into the upper mixed layer brought on by increased surface winds, or 2) winds decreased the mixed layer depth, slowed phytoplankton production, and allowed zooplankton to more efficiently graze the phytoplankton.

A relationship between oceanic conditions and increased production of a variety of nektonic fish and cephalopods has also been hypothesized (Beamish and Boullion 1993; Beamish 1994; Francis and Hare 1994; Polovina et al. in press; Beamish and Boullion 1995; Brodeur and Ware 1995; Hare and Francis 1995; Hollowed and Wooster 1995). One mechanism for this increased production could be the coupling of increased zooplankton production with transport into areas favorable for consumption by the zooplanktivores (Brodeur and Ware 1992). A general relationship between oceanic SST (as a proxy for other physical factors) and year-class strength of fishes has been hypothesized by Hollowed and Wooster (1995). They found in a review dating back to 1948 of 23 fish stocks that 43% had more frequent strong year-classes during a particular type of ocean temperature regime (e.g., warm or cool). A similar relationship has been hypothesized for Alaska salmon stocks but on a somewhat longer time-scale (Francis and Hare 1994; Hare and Francis 1995). One of the most compelling pieces of evidence supporting a linkage between ocean conditions and production is the strong year-classes of a number of Bering Sea fish stocks (e.g., walleye pollock, Pacific cod, Pacific herring) spawned at the onset of the current warm regime in 1976-77 accompanied by the apparent simultaneous decline in stocks of some other finfish (e.g., capelin; Anderson et al. 1994) and shellfish (e.g., pandalid shrimps, Albers and Anderson 1989; king crab, Otto 1989 and Kruse 1993).

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TOTAL ALLOWABLE CATCH vs. QUESTIONS OF SPATIAL AND TEMPORAL SCALE: A CASE OF LOCALIZED DEPLETION

by Lowell Fritz

In the Alaskan groundfish fishery, single-species fisheries management has attempted to maintain stock integrity by limiting total removals based on population dynamics and life history attributes. For some stocks, consideration is also given to the spatial and temporal pattern of harvest for both biological and allocative reasons. Examples of such time and area closure strategies include the partitioning of the Atka mackerel TAC among three areas in the Aleutian Islands and the walleye pollock TAC among four quarters and three areas in the GOA on the basis of their respective biomass distributions. These approaches operate on coarse scales with spatial units in hundreds or thousands of square miles and time periods of several days to several months. While they are valuable tools for aligning fishing effort with what is known about the distribution of fish biomass, these methods, as a part of traditional fisheries management, do not necessarily address unknown effects of smaller scale discontinuities in fishing pressure and fish density. If fish removals are disproportionately high relative to available biomass, localized depletions of the target stock may occur.

In the examples below, changes in the catch per unit effort of the GOA Atka mackerel fishery suggest that localized depletions of the species have been created by the fishery. Instances of localized depletion are only rarely documented perhaps by nature of their occurrence or because the requisite data to detect them have been lacking. Nonetheless, the potential impacts on both the target species and the surrounding marine community represent an area of concern which is particularly germaine to ecosystem management. While the impacts of the depletion are uncertain, the implications are cause for consideration and discussion, particularly given the uncertain status of Atka mackerel stocks in the GOA and ongoing efforts to recover Steller sea lions.

Methods

Leslie's method of catch per unit effort (CPUE) analysis provides a mechanism for estimating catchability (q) and the size of the original, pre-season population (N_0) from a time-series of catch and effort statistics through the following linear equation (Ricker 1975):

$$\frac{C_t}{f_t} = qN_0 - qK_t$$

where C_t and f_t are catch taken (mt of Atka mackerel) and effort expended (hours trawled), respectively, during time interval t, and K_t is the cumulative catch to the start of interval t plus half that taken during the interval. Catchability, the slope of the regression line, is defined as the proportion of N_0 that is captured with one unit of effort (one hour trawled). The x-intercept of the regression line is an estimate of N_0, since it represents the cumulative catch when the CPUE is equal to 0 (the entire population has been harvested). Harvest rates and local, time-specific fishing mortality rates (C/N_0 and $F=q*f$, respectively) can also be estimated. Confidence limits for the estimate of N_0 were calculated according to DeLury (1951) as cited by Ricker (1975).

There are two major assumptions when using Leslie's method to analyze CPUE data collected during periods of intense fishing. First, the exploited population is assumed to be closed, or at least that immigration and growth are equally balanced by emigration and natural mortality. Second, catchability is assumed to be constant over the time period of the fishery. Both of these assumptions may be met if the fishery occurs in a well-defined area and has a short duration. The Atka mackerel fishery in the GOA has occurred only in 2 (or 3) small areas since it became re-established in 1990. One is east of Simeonof Island in the Shumagin Islands, while the other one (or two) is south of the west end of Umnak Island (Figure 1). Since 1992, fishery durations in each area have each been less than one month in duration each year, and many have lasted less than 10 days.

All vessels targeting Atka mackerel in the GOA were catcher-processors subject to 100% observer coverage requirements. Data collected during the 1993 and 1994 Shumagin fisheries, and the 1992-94 Umnak fisheries were analyzed. To determine total removals of Atka mackerel from an area, the amount of Atka mackerel caught in an unsampled haul was estimated by multiplying the total catch by the Atka mackerel proportion in the sampled hauls during the same period for each vessel. Only those unsampled hauls in the same contiguous area and in a similar depth-range as the sampled hauls were included in the analyses. Catch and effort data for all hauls from the fleet were pooled over various intervals (=periods) to obtain the time-series used in the Leslie analyses, with no fishing-power correction applied between vessels. Period length varied from half-days to half-weeks in the time-area fisheries analyzed to insure that at least 10 hauls were pooled in each period and to have at least 4 points (=periods) for the regression analysis.

Results

Shumagins - The 1993 Shumagin fishery lasted 29 days, and 6 vessels caught 1,858 mt of Atka mackerel from the area (Table A1; Figures A1 and A2). The following year, the fishery lasted only 13 days, and 834 mt of Atka mackerel was caught by 4 vessels. The estimate of N_0 in 1994 (920 mt) was less than half that estimated for 1993 (2,199 mt), while the estimate of q increased three-fold (from 0.004 in 1993 to 0.012 in 1994).

Umnak - The area fished south of Umnak Island actually consisted of 2 smaller areas separated by the 10 nm trawl exclusion zone around the Steller sea lion rookery on Ogchul Island (Figure 1). The eastern area was fished only in 1992, while the western area was fished in each of the three years (1992-94). Catch and effort data for each subarea were considered separately for 1992. From the eastern Umnak area in 1992, 1,747 mt of Atka mackerel were caught in 9 days from 24 January through 1 February (periods 14-18), which was followed by sporadic fishing through early May (periods 26, 56, 60, and 71) when an additional 1,207 mt was caught (Table A1 and Figure A3). CPUE declines were only evident during the 24 January-1 February period, and yielded estimates of N_0 (1,970 mt), q (0.008), harvest rate (C/N_0=89%), and F (2.13). CPUE remained low through 15 February (period 26), suggesting that Atka mackerel had not immigrated to the area. Two months later (from 6-10 April, period 56), CPUE had increased, but only to about 70% of the level observed at the beginning of the fishery in late January. By mid-April (period 60) and early May (period 71), however, CPUEs were about 1.5 times greater than those observed in late January.

From the western Umnak area in 1992, a total of 9,868 mt of Atka mackerel were removed, however 8,382 mt were caught in an 18-d period from 16 April to 4 May (periods 31-35; Table A1 and Figure A3). The CPUE decline during these periods yielded estimates of N_0 (13,658 mt), q (0.001), C/N_0 (61%), and F (0.95) which suggested that the original population size of Atka mackerel in the western Umnak area was greater than that in the eastern Umnak area while catchability, harvest rate and the fishing mortality rate were smaller.

In 1993, only the western Umnak area was fished during 5 days in late March-early April. A total of 4,286 mt of Atka mackerel were caught by 11 vessels. CPUE did not decline during this fishery, so no estimates of N_0, q, C/N_0 and F were available (Table A1 and Figure A4). These data suggest that: (1) harvest rates were too small to significantly affect the size of the Atka mackerel population in the area in 1993 or (2) immigration was occurring during the course of the fishery which kept CPUEs high.

In 1994, only about half as much Atka mackerel were caught from the western Umnak area as in 1993. The fishery lasted only 3 days, and 8 vessels participated. The estimate of N_0 in 1994 (2,617 mt) was much lower than that estimated in 1992, while the estimate of q increased 15-fold (Table A1 and Figure A4).

Discussion

There were no separate GOA Atka mackerel TACs set in 1992 nor 1993; the species was included in the Other Species category in those years and the TACs were higher than the Atka mackerel catches. Consequently, catches of Atka mackerel in the GOA in those years could represent reasonably unrestrained fishery effort (except by market forces involving Atka mackerel supply). In 1992 at east/west Umnak, significant declines in fishery CPUE were observed over time during the short fisheries, yielding estimates of N_0 which sum to 15,628 mt.

Estimates of N_0 from Shumagin and W. Umnak suggest that the population of Atka mackerel in the GOA declined between 1992 and 1994. At Shumagin, N_0 estimates declined over 50% from 1993 to 1994 while estimates of q increased three-fold; at W. Umnak, estimates of N_0 declined over 80% between 1992 and 1994 while estimates of q increased 15-fold. At W. Umnak, it would appear that most of this decline came between 1993 and 1994, since the 1993 fishery, which took 4,286 mt of Atka mackerel, had no CPUE decline during the 5-day fishery. The increase in the estimates of q at the two areas suggests that: (1) the efficiency of the gear or fishery improved significantly, and/or (2) Atka mackerel continued to form dense schools, only fewer of them, as the population declined.

In 4 of the 5 fishery periods with CPUE decline shown in Table A1, harvest and local, time-specific fishing mortality rates exceeded 85% and 1.75, respectively. These rates of fish removal are very high, even for short-term, small-area fisheries, and suggest that the fishery created localized depletions of Atka mackerel. Emigration of fish, however, can not be discerned from these analyses; it is not known if some of the observed CPUE decline may have been a result of fish moving out of the area, perhaps in response to fishing pressure. At Umnak, the trawl exclusion zone may have prevented the fleet from following emigrating fish. However, it might be safely assumed that if the fish had emigrated, the fishing vessels would have attempted to follow them, at least at the Shumagin area.

There is only one example where fishery data were available in an area after the main fishery occurred to indicate the rate at which Atka mackerel may re-immigrate to an area. In period 26 of the 1992 E. Umnak fishery (2 weeks after the main fishery ended), CPUE was less than 15% of the initial level observed in period 14; by period 56, 2 months after the main fishery ended, CPUE had increased to only 70% of the initial level. The CPUE increase in periods 60 and 71 to levels greater than observed at the beginning of the 1992 E. Umnak fishery most likely reflects remigration of Atka mackerel into the area in higher densities related to the beginning of spawning in early summer.

The patterns of CPUE observed here and particularly at the Shumagins suggests that the GOA Atka mackerel fishery can have significant impacts on local fish abundances which may remain for weeks after the fishery has left the area. Given the uncertain status of Atka mackerel abundance and recruitment to the GOA and efforts to recover Steller sea lions, this analysis suggests that temporal and spatial aspects of fish removals be considered more fully in setting ABCs, managing fisheries, and recovering protected species.

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Table A1. Summary of Leslie analyses of Atka mackerel fishery CPUE data from the Gulf of Alaska.

Area	Year	Period Analyzed[1]	Vessels	Days	Sampled Hauls	Total Hauls	Sampled Hauls	Total Hauls(C)	N_0 (95%CI)	q	C/N_0	F[2]
			Number of				mt of Atka mackerel in:					
Shumagin	93	all	6	29	159	279	971	1,858	2,199 (1,924-2,677)	0.004	85%	2.06
	94	all	4	13	71	135	505	834	920 (763-1,227)	0.012	91%	2.21
E. Umnak	92	14-18	5	9	56	91	1,045	1,747	1,970 (1,802-2,172)	0.008	89%	2.13
	92	all	5		76	120	1,929	2,954				
W. Umnak	92	31-35	10	18	180	264	6,385	8,382	13,658 (11,310-18,144)	0.001	61%	0.95
	92	all	10		219	347	7,077	9,868				
	93	all	11	5	99	133	3,282	4,286				
	94	all	8	3	41	53	1,735	2,227	2,617 (2,030-4,925)	0.015	85%	1.77

[1]Period shown in accompanying figures; in those units (half-weeks, quarter-weeks, half-days, days, etc.).
[2]Time-specific local fishing mortality rates.

Figure 1

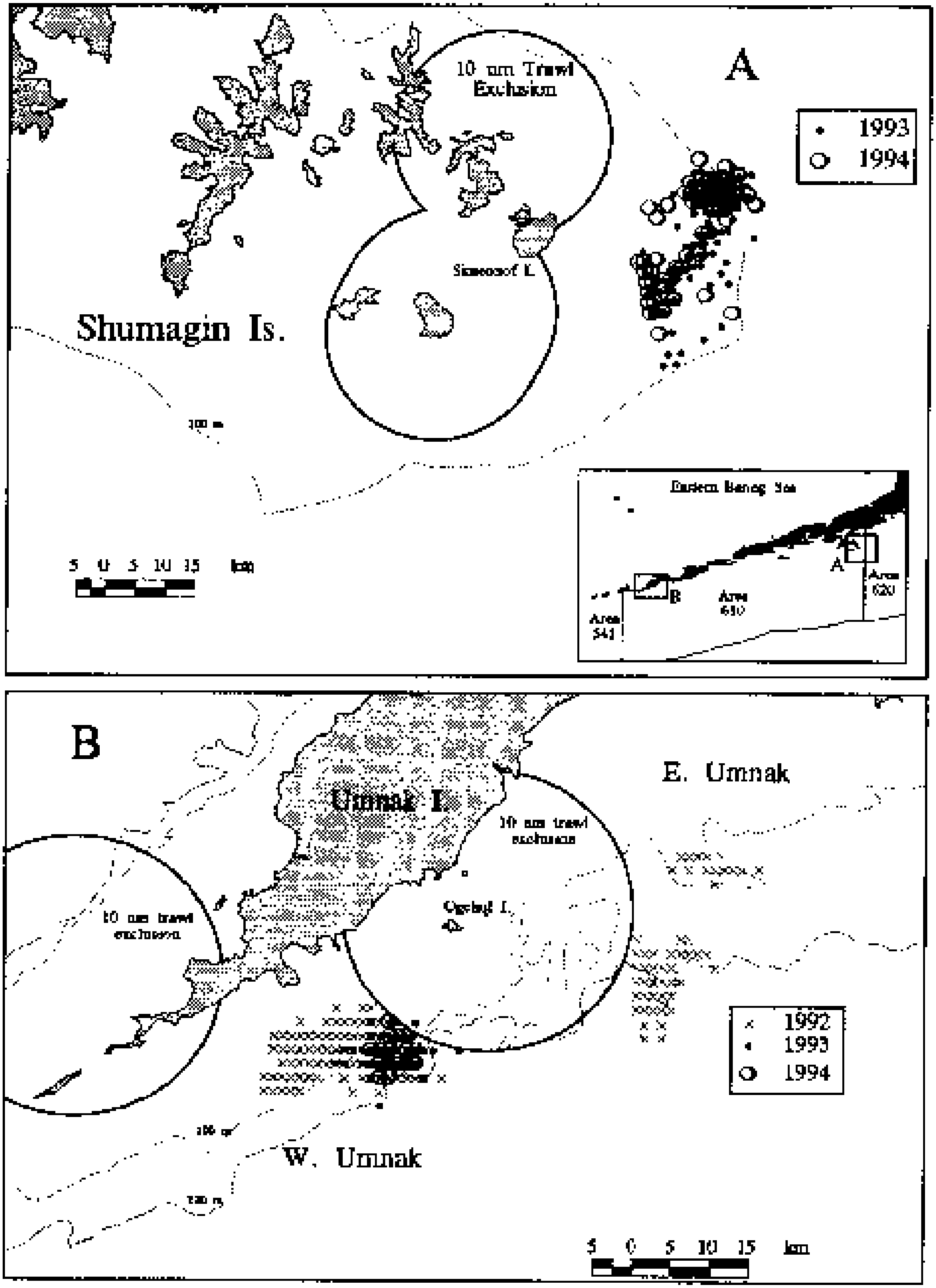

Figure A1. Trawl locations of GOA Atka mackerel fisheries in 1992-94 analyzed in this study. Inset in A shows location in western GOA of Shumagin Island (A) and Umnak Island (B) fisheries.

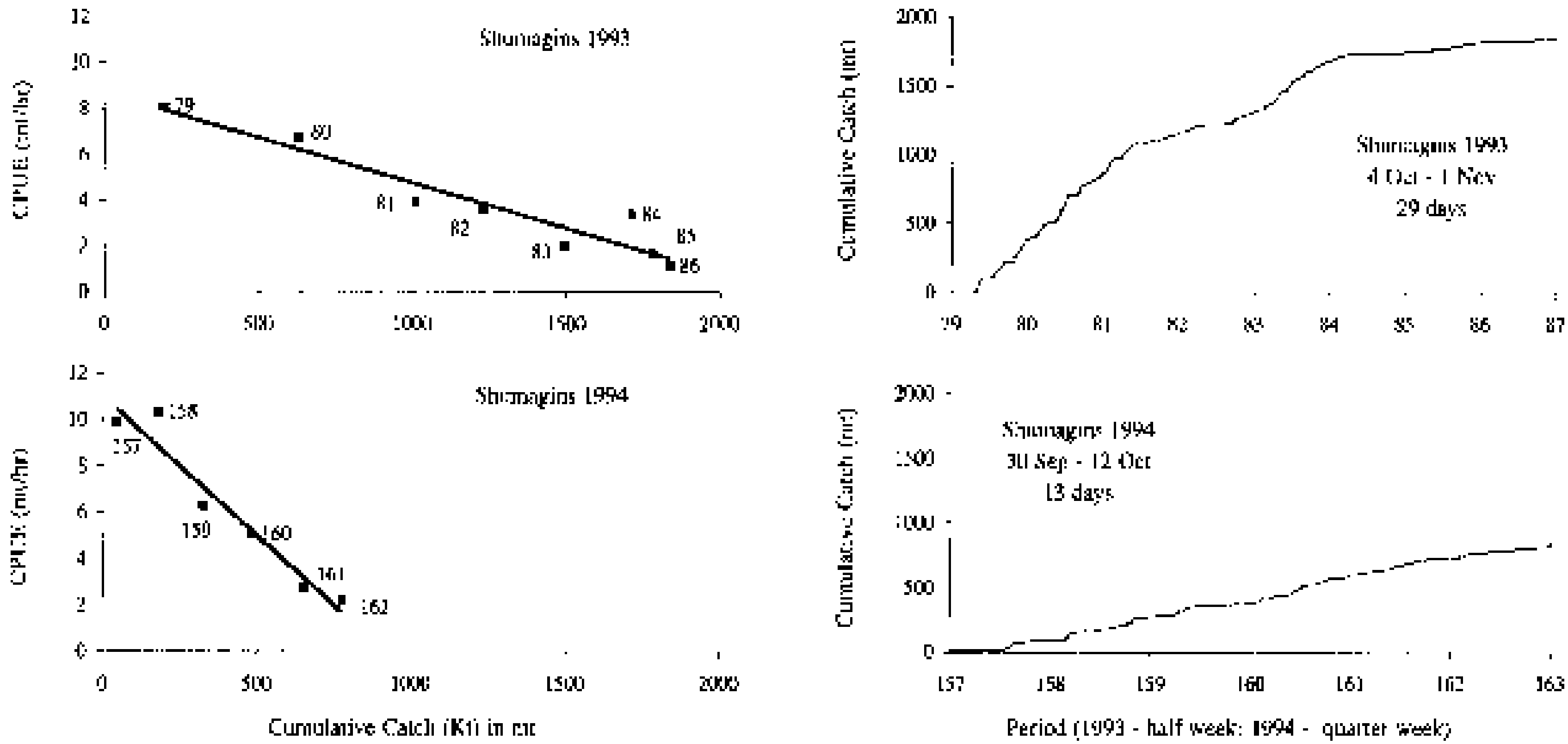

Figure A3. Results of Leslie analyses of catch per unit effort (CPUE) of the Atka mackerel fishery at the Shumagin Islands in 1993 and 1994. On the left, CPUE is plotted against Kt (Leslie cumulative catch) for the two years. Numbers next to data points indicate the period over which the data were accumulated. Cumulative catch curves are shown on the right, with period as the x-axes. In 1993, data were pooled by half-weekly periods; in 1994 quarter weeks.

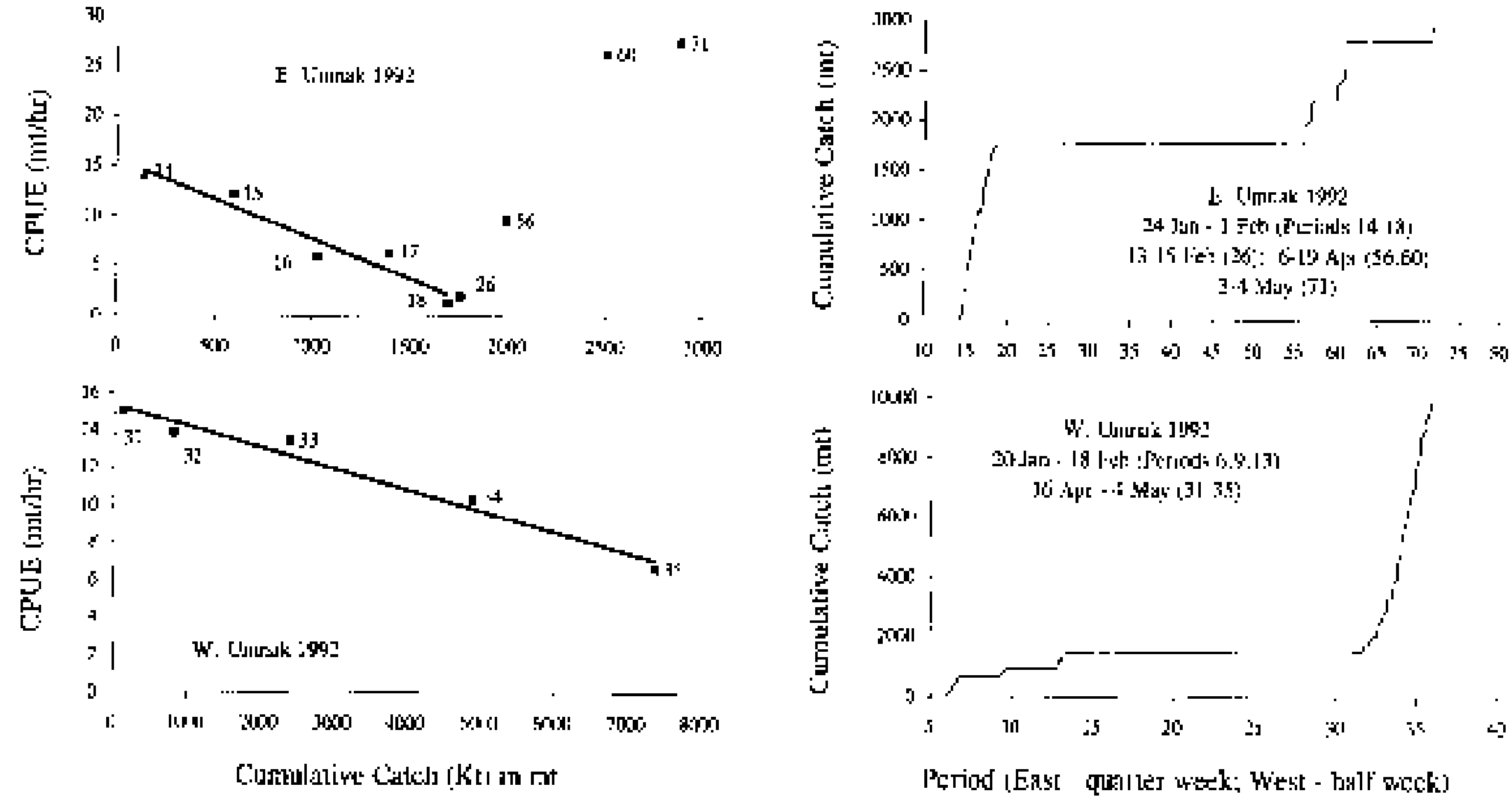

Figure A3. Results of Leslie analyses of catch per unit effort (CPUE) of the Atka mackerel fishery at Umnak Island in 1992. On the left, CPUE is plotted against Kt (Leslie cumulative catch) for the two areas in Figure A1. Numbers next to data points indicate the period over which the data were accumulated. Cumulative catch curves are shown on the right, with period as the x-axis. In E. Umnak, data were pooled by quarter-weeks; in W. Umnak, half weeks.

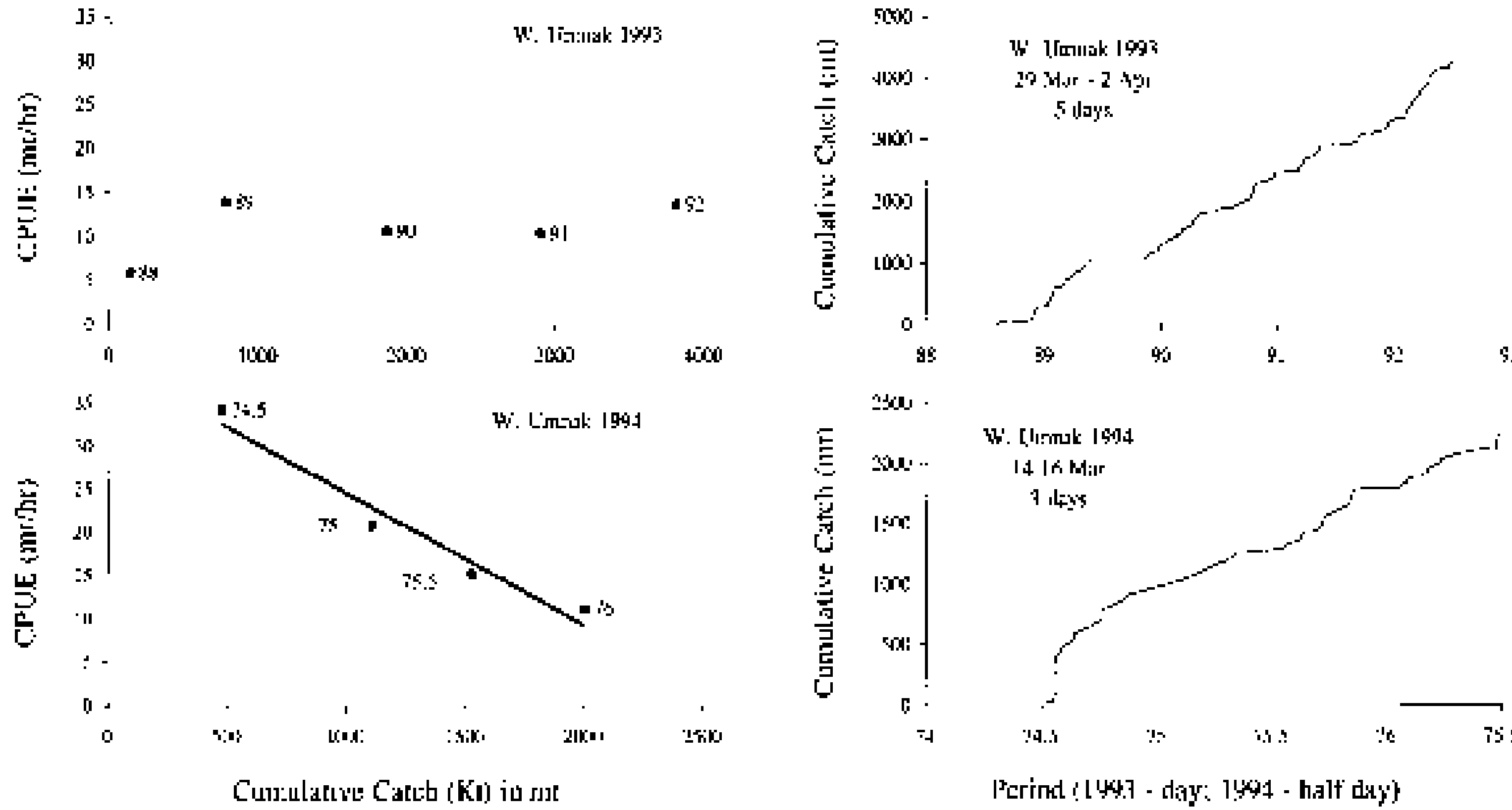

Figure A4. Results of Leslie analyses of catch per unit effort (CPUE) of the Atka mackerel fishery at W. Umnak Island in 1993 and 1994. On the left, CPUE is plotted against Kt (Leslie cumulative catch) for the two years. Numbers next to data points indicate the period over which the data were accumulated. Cumulative catch curves are shown on the right, with period as the x-axes. In 1993, data were pooled by days; in 1994, half days.